VOLUME XXX NOVEMBER, 1933 NUMBER 5

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

The AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

OFFICIAL ORGAN
THE AMERICAN ROENTGEN RAY SOCIETY
THE AMERICAN RADIUM SOCIETY

Editor: LAWRENCE REYNOLDS, M.D.

Editorial Board

A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board For Pathology

JAMES EWING, M.D. EUGENE L. OPIE, M.D.

ISSUED MONTHLY FOR THE AMERICAN ROENTGEN RAY SOCIETY
BY CHARLES C THOMAS, PUBLISHER, SPRINGFIELD, ILLINOIS

AMERICAN ROENTGEN RAY SOCIETY
Thirty-fifth Annual Meeting *Pittsburgh, Pa., Sept. 25-28, 1934*

AMERICAN RADIUM SOCIETY
Nineteenth Annual Meeting *Cleveland, Ohio, June 10-11, 1934*

FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY
Zurich, Switzerland · July 24-31, 1934

YEARLY SUBSCRIPTION, $10.00 SINGLE NUMBER, $1.50

The greatest ADVANCE in Radiography

...since the introduction of the Potter-Bucky Diaphragm

The first and only X-ray apparatus with a built-in system of standardized technique.

The TECHRON

THE TECHRON WAS INTRODUCED AT THE AMERICAN CONGRESS OF RADIOLOGY — CHICAGO — September 25-30, 1933

It was pronounced the outstanding X-ray development since the advent of the Potter-Bucky Diaphragm and received more favorable comments than any other X-ray apparatus on exhibition. It was accorded unanimous praise when Roentgenologists witnessed actual demonstrations—all radiographs routinely being of the same high quality—proving our contention—"result insurance."

- The Techron is a revolutionary development—a complete X-ray apparatus that coordinates the prime factors necessary to produce radiographs of true diagnostic value routinely. It is radically different; it is the answer to your technique problems.
- Nothing like the Techron has ever been known . . . yet it employs in its design principles in use by our research department since 1914—a standardized anatomical energy technique—guaranteeing uniform high quality radiographs consistently.
- You will like its appearance—unique in design, beautifully finished in either statuary bronze and polished brass or black velvet duco and handsome chrome nickeled hardware.
- You unquestionably want to know more about it. Fill in the coupon and slip it in the mail today.

Kelleket X-RAY EQUIPMENT

THE KELLEY-KOETT MFG. CO., INC.
203 West Fourth St., Covington, Ky.

Gentlemen: I am interested in the possibilities of The Techron. Send me descriptive literature (without obligation, of course).

Name .....
Address .....
City ..... State .....

NRA WE DO OUR PART

In answering advertisements please mention THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

JAN 18 1934

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XXX NOVEMBER, 1933 NO. 5

CONTENTS

Parathyroidsim—Its Clinical Symptomatology . . . MAX BALLIN, M.D. 571

Parathyroidism—Its Pathologic and Etiologic Classification . . . . . PLINN F. MORSE, M.D. 578

Rickets . . . . . RALPH S. BROMER, M.D. 582

Osteomalacia: A Brief Review of the Modern Conception of the Disease . . PAUL C. HODGES, PH.D., M.D., AND ALFRED C. LEDOUX, M.D. 590

Osteitis Fibrosa Cystica: Associated with Parathyroid Overactivity . . . . RICHARD DRESSER, M.D. 596

Giant Cell Bone Tumor . . . . CARLETON B. PEIRCE, M.S., M.D. 604

Ankylosing Spondylitis and Polyarthritis (Bechterew, Strümpell-Marie, and Related Types) . . . . . E. WALTER HALL, M.D. 608

Osteopoikilosis . . . . . LESLIE F. WILCOX, M.D. 615

Marble Bones . . . . . A. HOWARD PIRIE 618

Kashin-Beck's Disease . . . . . A. HOWARD PIRIE 621

Renal Rickets . . . . . EDWARD C. VOGT, M.D. 624

Osteogenesis Imperfecta . . . . . RALPH S. BROMER, M.D. 631

The Relation of the Thyroid, the Adrenals and the Islands of Langerhans to Malacic Diseases of Bone . . . . . ROSS GOLDEN, M.D., AND HODSON ABBOTT, M.D. 641

Schüller-Christian's Disease . . . RUSSELL S. ROWLAND, M.D. 649

Erythroblastic Anemia (Ccoley's Syndrome) . . F. F. BORZELL, M.D. 657

Roentgen Irradiation of the Parathyroid Region in Cystic Disease of the Bones and in Osteitis Deformans . . . . . E. A. MERRITT, M.D. 668

Foreign Body Removal with the Aid of the Double Plane Roentgenoscope . WILLIS F. MANGES, M.D. 674

Editorial

Roentgenology of the Gastrointestinal Tract 688

Society Proceedings, Correspondence and News Items 692

Department of Technique

"Chip-in" Method of Time-Temperature Tank Processing . . . . . S. W. DONALDSON, M.D. 695

Index to Abstracts 697

Abstracts of Roentgen and Radium Literature 698

GENERAL INFORMATION

Manuscripts offered for publication and other correspondence relating to the editorial management and books for review should be sent to Dr. Lawrence Reynolds, Editor, 110 Professional Bldg., Detroit, Michigan. Contributions may be sent in foreign languages and will be translated if found acceptable. Original articles are published only with the understanding that they are contributed exclusively to this JOURNAL.

A certain number of illustrations will be supplied free of cost; but special arrangements must be made with the Editor and Publisher for excess illustrations and elaborate tables.

Fifty reprints are furnished without charge to authors. Additional reprints may be purchased according to a scale of prices that accompanies galley proofs.

For information regarding membership in the American Roentgen Ray Society, address the Chairman of the Executive Council, Dr. Charles A. Waters, 1100 N. Charles St., Baltimore, Md.

For information regarding the program of the annual meeting, address the President-Elect, Dr. John T. Murphy, 421 Michigan Street, Toledo, Ohio.

Correspondence regarding subscriptions, advertisements, and other business relating to THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY should be addressed to Charles C Thomas, Publisher, 220 East Monroe Street, Springfield, Illinois. Foreign subscriptions may be addressed to Baillière, Tindall & Cox, 7 and 8, Henrietta Street, Cövent Garden, London, W. C. 2, England; H. K. Lewis & Co., Ltd., 136, Gower Street, London, W. C. 1, England; Maruzen Co., Ltd., 11–16 Tori-Sanchome, Nihon-bashi-Ku, Tokyo, Japan; Beutelspacher & Cia., Sarmiento 815, Buenos Aires, Argentina; W. Watson & Sons, Ltd., Watson House, Bligh Street, Sydney, Australia; or to your own agent.

Subscription price a year: $10.00, United States; $11.00, Canada; $12.00, other countries. Current single numbers, $1.50.

SUGGESTIONS FOR PREPARATION OF MANUSCRIPTS

Manuscripts should be typewritten, with double spacing, and good margins (not on thin paper) and the *original* should be sent to the Editor. The author should keep a carbon copy, as the original is not returned. The name of the author should appear on each sheet of manuscript. Tabular materials should be typed on separate sheets; likewise bibliographical lists, footnotes, etc.

Drawings and charts for reproduction should be made in black (*never* in blue). Photographic prints of plates or slides on glossy paper produce the best half-tones.

All photographs and drawings intended for illustrations should be numbered, the top plainly indicated, and an abbreviated title of the paper placed on the back of *each one*.

Legends for illustrations should be typewritten in a single list, with numbers corresponding to those on the photographs and drawings, instead of attaching each legend to its corresponding picture.

Care in preparation of bibliographies will save much time and correspondence. Each reference in a bibliography should include the following information in the order indicated: Name of the author with initials; title of the article; name of the periodical: year, volume, and page. It is requested that the authors use the following as a model:

1. Gardner, W. J., and Frazier, C. H. Ventriculography without air injection. J. Am. M. Ass., 1929, 93, 193–194.

The month should be given if the reference is to an issue of the current year. An alphabetical arrangement of authors is preferred.

The author should always place his full address somewhere on his manuscript. This is very important and is often omitted.

The American Journal of Roentgenology and Radium Therapy is owned, maintained by, and in the interests of, the American Roentgen Ray Society, Inc. It is issued monthly by Charles C Thomas, Publisher, 220 East Monroe Street, Springfield, Illinois.

The American Journal of Roentgenology and Radium Therapy does not hold itself responsible for any statements made or opinions expressed by any contributor in any article published in its columns.

Entered as second-class matter February 10, 1930, at the postoffice at Springfield, Illinois, and Menasha, Wisconsin, under the Act of March 3, 1879. Accorded the special rate of postage provided for in paragraph 4, section 412, P.L. and R.

Copyright 1933 by American Roentgen Ray Society, Inc.

©ClB 213770

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XXX NOVEMBER, 1933 No. 5

PARATHYROIDISM—ITS CLINICAL SYMPTOMATOLOGY*

By MAX BALLIN, M.D.
Harper Hospital
DETROIT, MICHIGAN

IT IS a most interesting experience in medical life to witness the development of a new medical entity from its beginning. This good fortune has come during the last generation to a good many of us who are now past mid-life by the development of a few most important new medical chapters, such as the etiology of infections and their treatment by asepsis and the discovery of your specialty, the roentgen ray. Parathyroidism** in comparison with these two great achievements is only a small chapter, but nevertheless most interesting, since, on account of its limited size, we have been able to study all its minute points from the beginning of its development. In our personal experience we have had the fascinating opportunity of learning the new chapter with its roentgenological signs in association with our roentgenologists. We used to go to them and ask, "What do I see?" but this time both they and the clinicians have had to learn together what parathyroidism is and how it expresses itself on the roentgenogram. Our program of today shows that now we have quite a few experts in detecting the roentgen signs; but it is not two years since Schouten complained that "Not one of the larger volumes of roentgenology gives any information on parathyroidism." The fourth edition (1931) of a most splendid American work on "Roentgenologic Interpretation" does not mention parathyroids as a factor in bony disorders. Yet a few of the illustrations are probably taken from such cases. Camp and Ochsner, in July, 1931, wrote: "No attempt has been made to regard certain changes as characteristic of parathyroidism and nowhere in the standard English and German textbooks on Roentgenology have we found the osseous changes accompanying parathyroidism presented." Since then a few authors, among them several clinicians, have written special articles on the roentgenology of parathyroidism.

The slow reaction of some to this chapter seems to me to be due to the fact that it is hard to get away from the set idea that osteitis fibrosa cystica is an entity, that bone cysts are another entity and giant cell

** We use the word parathyroidism; it tells just as much as hyperparathyroidism, is not as complicated and does not lead to mistakes. We have proposed this in our publications. Cushing in his recent article on "Basophil Adenomas of the Pituitary Body" also presents the same reasoning in connection with hypo- and hyperpituitarism. The terms are too clumsy and easily lead to mistakes.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932. The fol'owing papers were also given in the Symposium on Malacic Diseases of Bone but for various reasons were not available for publication at this time. They will appear later: "Primary Hyperparathyroidism" by E. R. Witwer, M.D.; "Paget's Disease" by Cornelius G. Dyke, M.D., and Haig H. Kasabach, M.D.; "Decalcification (in other endocrine disturbances); Pituitary Origin (Basophil Adenoma)" by M. C. Sosman, M.D. (this will appear as part of a paper by Dr. Sosman on "The Diagnosis of Pituitary Adenomas from the Roentgenologist's Viewpoint").

sarcoma again an entity, and that the most prominent men still publish entities obviously belonging to parathyroidism under such names as I have just mentioned. The time has come when many of the bony changes can be classified to much greater advantage under their etiological factors. In our special case they should now be classified as parathyroidism and not as cysts and so on. Lièvre, a Frenchman, has succeeded in publishing the first textbook on parathyroidism. Its title is "L'ostéose parathyroïdienne et les ostéopathies chroniques," showing by this title that there is a distinct parathyroid entity in skeletal diseases. If roentgenologists will take the lead in diagnosing this entity properly instead of reporting osteitis fibrosa cystica or cyst, giant cell sarcoma, Recklinghausen's or Paget's disease, the clinicians will follow, as they customarily do, and a much better understanding of the entities will result and lead, incidentally, to the proper treatment.

Skeletal changes may be caused also by other endocrine disturbances than the parathyroid. Hunter and others have shown that thyroid dysfunctions may cause certain disturbances in the distribution and deposition of calcium. Certain forms of arthritis are due to thyroidism. The Cushing syndrome of basophil adenoma of the pituitary—in other words, pituitarism—is accompanied at times by skeletal changes, and the great complexity of symptoms called xanthomatosis or disturbance of the lipoid metabolism also has skeletal changes as an outstanding symptom (Schüller-Christian, Rowland). In certain splenic disorders in children skeletal changes are likewise prominent (Cooley, and others). Whether in these symptom-complexes a polyglandular syndrome exists including a parathyroid disturbance or whether the parathyroid is secondarily affected if there is any breakdown in the endocrine equilibrium is much discussed but not settled at this time.*

To understand the parathyroid disturbance properly, it is of the utmost importance to have a few basic facts in mind. First, if a parathyroid is irritated by hyperplasia or by an adenoma, its function will be stimulated, more parathormone will get into circulation, and this parathormone leads to decalcification of the skeleton. This again expresses itself by an increase of calcium in the blood serum accompanied by a decrease of the serum phosphorus. A negative calcium and phosphorus metabolism is the result; also an increased secretion of calcium and phosphorus in the urine will result. This premise now has to be accepted as a fact. Numerous experiments have been made showing that by injecting parathormone over a period of weeks or by giving large doses in short periods one can reproduce all the symptoms of parathyroidism. The increased parathormone put into circulation will cause hypercalcemia and this increased quantity of calcium in the blood is taken from the great calcium storehouse, the skeleton. This principle being fixed in our minds will help us to understand all the roentgenologic changes we find in parathyroidism. Besides this experimental proof that parathyroid extract in overdoses really is responsible for the syndrome of parathyroidism we have a second practical proof, that is, the clinical evidence that the serious symptoms of the disease are cured by parathyroidectomy, be it the removal of an adenomatous parathyroid or be it a hyperplastic parathyroid.

Comparative studies of other endocrine glands are most interesting. Thyroid extract, if taken in toxic doses, will produce thyroidism. Its cure by operation is well known. Overdoses of insulin will produce hyperinsulinism, the same disease that we now know is caused by adenomatous and hyperplastic processes of the islands of Langerhans. Thus, the parallel can be

* As to the polyglandular upset occurring in these conditions new studies of the cell types in the pathology of all endocrines show that in certain conditions the basophil cells are more disturbed, in others, the eosinophils. This idea is still perhaps controversial, but since these cell disturbances have been observed in all these glands it opens a more understandable view that perhaps these cell groups are the actual carriers of the pathological processes now called endocrine. However, we could understand why the polyglandular upset happens so frequently.

drawn all through the endocrine system.

As to the etiology of parathyroidism, the hereditary element and thereby constitutional makeup, obviously, are prominent factors in its production. A family with osteitis fibrosa cystica in three members, another family with osteopoikilosis in several members, brought under our observation at Harper Hospital, and many other such observations in the literature are proof of the important rôle heredity plays in this group. In another place in our contribution it is brought out that temporary osteomalacic conditions caused by nutritional defects are usually remedied by proper dietetic measures but at times are the origin of a permanent parathyroidism. Dislike for milk has been observed by Hunter and others in the records of their cases. Milk being a main carrier of calcium in our food, this is of etiological significance. As in thyroid pathology we have an endemic goiter, also we know of endemic osteomalacia. Kashin-Beck's disease, to be discussed later, shows that regional conditions may produce decalcification with parathyroid symptoms. In at least 10 of the cases recorded the onset of parathyroidism followed early surgical menopause.

The subjective symptom of the patient in the beginning of his affection is usually pain and the pain is located in the hips and radiates down the legs. *Back leg ache*, I understand, is a known entity in China where osteomalacic conditions seem to be more frequent. For this reason the patient will usually go to the roentgenologist to be examined for sacroiliac disease and many of our patients started their therapeutic efforts with sacroiliac belts and corsets. Later on, however, the pain will attack other bones, arms, chest and even skull. Patients past middle life frequently notice, besides the pain, a bowing of their limbs. They grow shorter and become kyphotic even if they are not confined to bed. A few exceptional cases noticed first a swelling caused by a giant cell tumor in a metatarsus or metacarpus as an early symptom, but usually such symptoms are only present in well-developed, advanced cases. The muscular weakness may be an early symptom and should be an indication to watch for parathyroidism. In at least half a dozen cases in the literature severe vomiting due to the hypercalcemia and perhaps to metastatic calcium deposits in the intestines was the early symptom.

The pathological mobilization of calcium from the skeleton under the influence of exaggerated parathyroid activity expresses itself:

1. Biochemically, by the change in the calcium and phosphorus content of the blood and in the metabolism of these elements.

2. Roentgenologically, by bone changes we shall speak about.

3. By changes in muscle tonus. Hypercalcemia leads to lessening of the muscle tonus and this can be measured by the milliamperes needed to contract the muscle (4 milliamperes normal, 7 in parathyroidism, 1–2 in tetany). By the increase in chronaxie, that is, grossly, the time interval between the stimulus and the contraction of the muscle (0.028 second normal, 0.042 in parathyroidism, 0.018 and less in tetany). As to symptomatology, patients complain of lassitude in their muscles, fatigue, frequent falls without cause. The slow muscle action has also been shown in a moving picture (Rowntree) and may be seen, since it also affects the heart muscle, in the electrocardiogram; the so-called R–T interval being long in the tetanic heart muscle and much shortened in parathyroidism (R-T interval: normal 0.026–0.028, in parathyroidism 0.022 in tetany up to 0.034.

4. Secondary calcium deposits. The hypercalcemia will lead to secondary calcium deposits in certain places where infections or other conditions may cause roughening and make an especially inviting location for such deposits from the blood overloaded with calcium. This secondary calcium deposit along the vertebral ligaments, in the intervertebral discs, in blood vessels, perhaps also ribs and internal organs, is

quite important. With the hypercalcemia it causes the gastrointestinal symptoms, the severe vomiting present in some cases of parathyroidism, the albuminuria and other urinary symptoms and, finally, stone formations which accompany a remarkable number of cases of parathyroidism. Besides these gross calcium deposits visible in the roentgenogram, many microscopical specimens now show widespread calcium deposits in liver, spleen, intestinal mucosa, kidneys, etc., in the course of parathyroidism or in post mortems. By understanding these secondary calcium deposits we will also meet with a little friendlier attention than has been the case so far in certain cases of arthritis which Oppel has claimed as being due to parathyroidism. It has been my experience that if one speaks about this symptom of parathyroidism the discussion always follows that arthritis is not caused by parathyroidism, and has nothing to do with it. No one has ever claimed that arthritis in general is of parathyroid origin, but under certain conditions, that is, if hypercalcemia exists, secondary calcium deposits will lead to ankylosis in an otherwise not ankylosing arthritis, and, therefore, parathyroidectomy will prevent and even cure some of these beginning cases of ankylosing arthritis; but to diagnose them, other parathyroid disturbances such as hypercalcemia or severe muscle hypotonia are necessary. Again, arthritis as a symptom is present at times in parathyroidism, but this statement should not be made general to cover the whole chapter of arthritis. Proper diagnosis of the few arthritic cases belonging to this group will prevent mistakes and discrediting of this chapter.

Coming back now to the roentgenological symptoms of parathyroidism, these will be taken up by one of the later speakers in our symposium. I may remark here only that as in practically every pathological condition not one symptom alone is pathognomonic. To speak to the point, absence of roentgen findings should not always exclude the diagnosis of parathyroidism. I realize that the cases without any roentgenographic evidence are rare and they may be still rarer if the whole skeleton is always examined by the roentgenologist. Three cases will illustrate the point, but there are several others on record:

1. Pemberton and Geddie published a case of a girl fourteen years old, whose chief symptoms were loss of weight, from 86 to 55 pounds, and most severe vomiting spells lasting over days, polydipsia and polyuria, and a serum calcium of 17.6 mg., a negative calcium balance of 0.21. The removal of a parathyroid adenoma cured this patient and the only roentgen finding was a diffuse rarefaction of the bones without any localization. Incidentally, this brings out the importance of having comparisons with standard bones to measure the milder degrees of decalcification, such as comparison with normal bones of the same age, and so forth.

2. A second case of our own concerned a woman about forty years old, who had as the principal symptom a hypotonia of the muscles so that she could hardly walk. The hypotonic muscles were also very painful. There was an increase in the serum calcium, but the only roentgen finding was a disputable decalcification of the pelvis. However, removal of hyperplastic parathyroids brought good relief of her symptoms.

3. The third case is the striking one, that of Bergstrand. This is a case where a parathyroid tumor was actually visible in the roentgenogram of the neck looking like and interpreted first as an aneurysm of the innominate. The case came to autopsy and showed the large tumor that had caused the shadow. The case also showed the typical changes in chemistry and so on. Still the roentgenologic findings during life were absolutely negative. At autopsy, however, the skull cap gave the first intimation that there was some osteitis fibrosa cystica present. The femora and vertebrae looked normal even on roentgenograms taken after autopsy. When these bones that grossly and roentgenologically showed no

changes were examined microscopically an extensive osteitis fibrosa cystica was found. This is quite important. Several pathologists and clinicians specializing in these investigations have proved that in monostotic cysts microscopically the process is far more extensive in the skeleton so that the designation monostotic is not justified. The monostotic Paget changes in the same way will pathologically not stand this name, as they also are, at least microscopically and often roentgenologically, multiple.

Therefore, if there are no skeletal findings or only the very slightest findings of parathyroidism in the roentgenograms, this should not necessarily exclude the diagnosis of parathyroidism if other symptoms prove the diagnosis.

In the same way hypercalcemia and hypophosphatemia and the other disturbances in metabolism are symptoms usually present in the well-developed case, but they may be absent temporarily or very slightly pronounced in the more chronic cases, especially in the arthritic group and the group we find in older people and if you want to include Paget's disease in this chronic type of the affection. The laboratory worker in his enthusiasm over the wonderful progress that has been made in understanding this biochemistry from a parathyroid point of view will miss the diagnosis a good many times if he insists on his findings. They are not necessarily present in every case or at least only mildly pronounced. In other words, the absence of a hypercalcemia and the other chemical symptoms should not counteract the diagnosis of parathyroidism if clinical and roentgen findings and hypotonia, for instance, speak in favor of the diagnosis.

The symptoms of hypotonia again are usually present and some French authors (Bourguignon) even believe that they are much more constant than the calcium disturbances, but in certain well-developed cases that have been proved by successful operation to be of parathyroid origin for some reason or other the changes in chronaxie are not present. If we compare again other pathological and endocrinological conditions, there is not one pathological entity where, even occasionally, a symptom considered most pathognomonic may not be absent. We have a scarlet fever without rash, we have an aleucemic leucemia and we have a thyroidism without an increase in metabolism. If we operated upon only the cases of goiter that have a high metabolic rate we would miss over 25 per cent of goiters that could be benefited and cured by thyroidectomy. I have gone into this part of the symptomatology perhaps a little too extensively but usually the physician and surgeon look to the roentgenologist to decide the question of parathyroidism.

These various symptoms and osseous changes of parathyroidism will be taken up by other speakers in the symposium.

In the differential diagnosis we have to consider chiefly the exclusion of malignant conditions, metastatic carcinoma of the breast, prostate, and so on. Experienced roentgenologists will have little trouble in excluding most of these conditions. More difficult it seems to be to exclude myeloma. In this condition, as in all other doubtful osseous symptoms, a biopsy is frequently urgently indicated. In a few cases of myeloma we were able to get satisfactory biopsy material from rib foci especially, and in 2 other cases a superficially located myelomatous lesion of the skull gave suitable material for biopsy.

A further diagnostic difficulty is the exclusion of the temporary parathyroid disturbances as they occur in late rickets and osteomalacia, puerperal as well as the type caused by famine or absence of certain vitamins in the food. For this type, if any doubt exists, the therapeutic test is most valuable. Such patients will improve immediately under proper diet, the administration of vitamins, ultraviolet rays, and so forth. Even with all these means the real case of parathyroidism will not improve. A parallel to this exists in the better known picture of thyroidism. The goiter of puberty and pregnancy is just an expres-

sion of the functional adaptation of the thyroid gland to the increased demand for its product in such periods of development. At the same time in rickets and osteomalacia the parathyroid glands' increase in size is an adaptation to the increased demand for its hormone during these disturbances of calcium metabolism; but, as in goiter, these physiologic goiters are apt to become permanent, also rickets and osteomalacia, especially the one after pregnancy, are sometimes just the beginning of a real parathyroidism.

THE TREATMENT OF PARATHYROIDISM

The literature shows that medical treatment with calcium, parathyroid extract, and light, has been of no avail in the rightly diagnosed case. The names of Snapper, Hunter and many other medical men, not surgeons, who have issued this dictum after trying medical care in a good many cases should be sufficient. Moreover, the administration of parathyroid extract and calcium in this condition makes the patient worse just as thyroid extract will usually aggravate the symptoms of a toxic goiter. To be sure, a trial will not do any harm just to exclude the possibility of a temporary parathyroid disturbance, but it should not be continued until severe deformities of the bones and nephritic disturbances render the outlook serious.

The roentgen treatment of parathyroidism will be discussed in a later paper on this program. The treatment in some hands has not been successful, but its trial is rational as an effort to shrink the hyperplastic or adenomatous glands. If this should fail, removal of the adenomatous glands is indicated, is life saving at times and at other times will bring an invalid patient back to normal and prevent great deformities.

A good deal has been written as to whether only tumors of the parathyroid should be removed and not "normal" parathyroids. Even under the microscope it is very difficult to decide what is pathological and what is normal. To be sure, if we find an adenoma of the parathyroids of some size, say 1 cm. (they have been found up to 6 and 7 cm. in exceptional cases), the issue is a clear one, but the apparently normal parathyroid may show cell changes only distinguishable by the skilled pathologist. It took a long time to understand the intimate pathology of the exophthalmic goiter and no one can doubt any longer that there are cell changes in such goiters responsible for the affection. The results of operations and the removal of only more or less hyperplastic parathyroids without gross changes are the final proof in this question. In removing the parathyroids naturally postoperative tetany has to be guarded against. One should always be sure that one or two functioning parathyroids are left, better two. If in doubt it is best to remove only one or two parathyroids, whether adenomatous or hyperplastic, and if the symptoms require the removal of more parathyroid tissue it should be done at a second sitting. Postoperative treatment of the patient with parathormone as with Lugol's solution after thyroidectomy will take the patient over the postoperative danger period and prevent tetany during the time needed for accommodation to this removal.

The result after operation is most striking, especially the immediate cessation of the unbearable pain that had required morphine and other anodynes for a long time. Patients who have been brought in in an ambulance and could not be turned in bed without causing extreme pain feel free of pain and can be moved comfortably on the first and second postoperative day. Such immediate changes after operation are also observed in other endocrine conditions. Recalcification of the bones after operation has been observed to begin in six weeks, but usually takes longer and sometimes has not been present even a year and more after the operation; still the bone pain has ceased and the function returned. Bone cysts will solidify very rapidly and giant cell tumors will be replaced by good osseous tissue.

In conclusion, a few remarks, are perhaps of importance to the roentgenologist, which are founded on an extensive survey of practically all the literature on the subject of parathyroidism and a personal experience of 50 operated cases and many more clinical and pathological observations:

1. The findings of a monostotic cystic process, a giant cell sarcoma or enchondroma should be an indication to survey by roentgen examination more or less the whole skeleton, spine, pelvis and skull especially, and will often show general changes where only a localized process is outstanding, but general osseous changes would give an entirely different clinical aspect.

2. Also monostotic Paget's disease will show more or less generalized osseous changes if examined very thoroughly.

3. Vertebral compression, acquired without appreciable injury, without metastatic malignancy should lead to a survey of the whole skeleton and investigation for other parathyroid symptoms.

4. Slipping epiphysis, coxa vara, and pathological fractures not caused by malignancy, should also remind us of the possibility of parathyroidism.

5. A few cases of parathyroidism simulate neurological and vasomotor disturbances, the softened bones causing pressure on the nerves and perhaps the cord. The hypotonia of the muscles causes the cyanotic appearance of the legs. A combination of neurologic and vasomotor symptoms with findings of osteoporotic processes should invite examination for parathyroidism.

REFERENCES

1. Ballin, M. Technique of parathyroidectomy. *Surg., Gynec. & Obst.*, 1932, *54*, 806–808.
2. Ballin, M. Parathyroidism. *Ann. Surg.*, 1932, *96*, 649–665.
3. Ballin, M., and Morse, P. F. Parathyroidism. *Am. J. Surg.*, 1931, *12*, 403–416.
4. Ballin, M., and Morse, P. F. Parathyroidism and parathyroidectomy. *Ann. Surg.*, 1931, *94*, 592–609.
5. Bergstrand, H. Ostitis fibrosa generalisata Recklinghausen mit pluriglandulärer Affektion der innersekretorischen Drüsen und röntgenologisch nachweisbarem Parathyreoideatumor. *Acta med. Scandinav.*, 1931, *76*, 128–152.
6. Bourguignon, G., and Sainton, P. Chronaxie in hyperparathyroidism; study of a case of osteitis fibrosa de Recklinghausen with Paget deformities. *Compt. rend. Soc. de biol.*, 1931, *107*, 5–8.
7. Camp, J. D., and Ochsner, H. C. Osseous changes in hyperparathyroidism associated with parathyroid tumor; roentgenologic study *Radiology*, 1931, *17*, 63–69.
8. Cooley, T. B. Likenesses and contrasts in hemolytic anemias of childhood. *Am. J. Dis. Child.*, 1928, *36*, 1257–1262.
9. Cushing, H. Basophil adenomas of pituitary body and their clinical manifestations (pituitary basophilism). *Bull. Johns Hopkins Hosp.*, 1932, *50*, 137–195.
10. Dresser, R., and Hampton, A. O. Osteitis fibrosa cystica generalisata with hyperparathyroidism as etiology. Am. J. Roentgenol. & Rad. Therapy, 1931, *25*, 739–748.
11. Holmes, G. W., and Ruggles, H. E. Roentgenologic Interpretation. Fourth edition. Lea and Febiger, Philadelphia, 1931.
12. Hunter, D. Goulstonian lectures entitled significance to clinical medicine of studies in calcium and phosphorus metabolism. *Lancet*, 1930, *1*, 897; 947; 999.
13. Lièvre, J. A. L'ostéose parathyroïdienne et les ostéopathies chroniques. Masson et Cie., Paris, 1932.
14. Oppel, V. A. Parathyroidectomy for ankylosing polyarthritis. *Ann. Surg.*, 1929, *90*, 978–981.
15. Pemberton, J. de J., and Geddie, K. B. Hyperparathyroidism. *Ann. Surg.*, 1930, *92*, 202–211.
16. Rowland, R. S. Xanthomatosis and reticuloendothelial system. *Arch. Int. Med.*, 1928, *42*, 611–674.
17. Rowntree, L. G. *Staff Meetings Mayo Clinic*, Nov. 18, 1929, 681.
18. Schouten, D. E. Extirpation of parathyroid gland in osteitis fibrosa. *Nederl. tijdschr. v. geneesk.*, 1931, *75*, 252–255.
19. Snapper, I. Parathyroid tumor and changes of bones. *Arch. Int. Med.*, 1930, *46*, 506–523.

PARATHYROIDISM—ITS PATHOLOGIC AND ETIOLOGIC CLASSIFICATION*

By PLINN F. MORSE, M.D.
Harper Hospital
DETROIT, MICHIGAN

THIS symposium has been arranged in order that a complete survey of the question of malacic diseases of bone may be made, and to give all those interested in the subject an opportunity to discuss the various diseases of this group from their different points of view.

Fragility of bone leading to pathological fracture or to other disturbing symptoms may be due to a great number of causes, and a large number of diseases come under consideration when we discuss this subject. Not all of the conditions discussed this morning will belong properly to malacic disease of bone as such, but they have been included in this discussion for the reason that their roentgen appearances are such that the question of differential diagnosis by the roentgenologist often arises. The following list of diseases will be considered, and each will be taken up by a roentgenologist who has had special experience with that particular disease or special interest in its study:

Osteogenesis imperfecta
Fragilitas ossium
Rickets
Osteomalacia
Bone fragility in other endocrine disturbances
Renal rickets
Osteitis fibrosa
Osteitis deformans (Paget's disease)
Leontiasis ossium
Giant cell tumors
Ankylosing polyarthritis (Oppel)
Multiple myeloma.

Before entering upon the detailed discussion of each disease, a few remarks may be in order as to the classification of this group and the etiological relationships which divide them, both for purposes of diagnosis and treatment. For our purpose, I think they may best be grouped according to the primary defect of metabolism which, in the light of our present knowledge, we believe is responsible for each group in turn.

In our first group, we place those diseases in which the primary defect is in the mesoblast. In these diseases the mesoblastic tissue as a whole all over the body is probably defective, and as a result of that, the ability of the osteoblastic forming cells to lay down the connective tissue groundwork for bone is lacking. The bones are fragile, not because there is any primary defect in the calcium metabolism, but because the connective tissues are unable to build up a sufficient groundwork upon which enough lime may be deposited. In this class comes osteogensis imperfecta and fragilitas ossium, probably the same disease, except that in the first case we are dealing with the fetal or infantile manifestation of the affection and in the latter case with the expression of the same pathological process in the adult. These diseases have a particular tendency to be hereditary and familial; to be characterized by multiple fractures which heal normally; to give evidence of their presence by the characteristic blue sclerotics of those affected in this way, and also to show various evidences of multiglandular endocrine disturbances of more or less indefinite form. The important fact is that, as far as we know now, the disease is a primary, congenital, hereditary defect of the mesoblast, and is not amenable to any of the ordinary medical or surgical measures which have been found to affect some of the other malacic diseases of bone favorably. It will be noted that in

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

both of these diseases the blood calcium and phosphorus levels are usually normal. Fractures, when produced, seem to heal just as promptly as they do in normal bone, but the bones themselves are especially fragile simply because the groundwork for the laying down of lime is insufficient.

In the second group, we place those diseases which are due to a primary defect of lime absorption and fixation. This, in turn, is due either to a deficient intake of calcium in the food, or to an intake insufficient to meet the need of unusual physiological demand, or to a deficient vitamin D intake, or to all of these factors combined. In this group we place rickets and osteomalacia proper; again, probably the same disease, rickets being the infantile type of the disease as it expresses itself in the growing bone, and osteomalacia as it expresses itself in the bone of the adult. Our division of osteomalacia into puerperal, senile, endemic, hunger, and other types is, of course, purely artificial and based upon the particular environmental factor which has called the disease out. Here we have no mesoblastic defect. There is no deficiency of connective tissue, and no lack of capacity on the part of the bone-forming cells to lay down sufficient groundwork for lime to be deposited upon, but the dyscrasia is one having to do with the inability to fix lime in the new-forming bone or inability to obtain enough lime for this purpose. In these cases again we usually find no disturbance in the blood calcium levels. The phosphorus levels are also usually normal, except in those atypical forms of rickets known as high-phosphorus rickets which probably have other relationships. It would be more proper to say that the blood calcium levels are not raised than to say that they are normal, because often in both these diseases low levels are found even to the point of producing marked tetanic symptoms, so that we have rickets with tetany and osteomalacia with tetany rather commonly. It is evident then from this analysis, that the proper treatment of these two diseases is medical in that if a proper calcium intake is assured, if proper measures are taken in the gastrointestinal tract to insure the absorption of lime by maintaining a proper acidity of the intestinal content, and if enough vitamin D is furnished the body economy to allow proper lime fixation to go on, normal conditions will be restored and we can usually expect a cure of both of these conditions by medical means alone. On the other hand, we must remember that in both rickets and osteomalacia, secondary hyperplasia of the parathyroid gland is the rule, and that in both these diseases we may be confronted in later life with a condition quite similar to the situation that we find sometimes following the adolescent forms of goiter, in that the hyperplasia may be persistent in later life and operative care of the parathyroid may become necessary on account of persistent hyperfunction of the parathyroid called out originally by the functional demands of the original rickets or osteomalacia. It should be emphasized, however, that ordinarily rickets and osteomalacia are not primarily parathyroid in origin and not ordinarily amenable to surgical treatment.

The third group is a rather unsatisfactory one, in that we have used it as a dumping ground for all those conditions which do not seem to fit in elsewhere. In general, it is a characteristic of all these to show an increased lime excretion in the urine, in other words, a sort of leakage of lime due possibly to various causes, but associated with various diseases of other endocrines. The first of these has to do with the pathological fractures that sometimes occur as a result of diffuse bone malacia in severe cases of exophthalmic goiter. Again we find in pancreatic diabetes with marked sclerosis of the pancreas, sometimes diffuse bone malacia possibly related to a chronic acidosis. Cases of basophil adenoma of the pituitary also are commonly affected by bone decalcification sometimes strikingly like those in so-called parathyroid cases, and it has also been reported that certain cases of adrenal tumor have shown un-

usual decalcification of bone. This group is merely mentioned in order to show that in any specific incident of bone malacia a careful study of all the endocrine system should be made before any conclusions are arrived at relative to a specific etiology.

The next group contains one very interesting disease, namely, renal rickets. The bone malacia in renal rickets is one of the most striking which the pathologist sees. In the severe cases practically all the bones of the body may be cut freely with a knife with no evidence of lime salts remaining in the skeleton. The primary lesion in these cases is a nephritis of the contracted kidney type associated with a general arteriolar degeneration and hypertensive phenomena. The primary defect is probably phosphorus retention. The result of this phosphorus retention is the same as we find in young animals in which a high level of blood phosphorus is maintained experimentally, namely, a very marked responsive hyperplasia of the parathyroid gland. The responsive hyperplasia from the parathyroid gland is undoubtedly brought about in an effort to lower the blood phosphorus level, and its secondary result in this case is to increase the blood calcium and to draw upon the lime reserve in the skeleton and diffiusely decalcify the bones. The important practical lesson to be learned, of course, is that this disease is primarily a nephritis of very severe grade, and by the time the roentgenologist or the clinician who recognizes it as renal rickets sees it, the condition has gone on far beyond any therapeutic help, and removal of the parathyroid gland or any other therapeutic measure with the idea of alleviating the affection is not to be thought of.

In the next group, we put a collection of diseases which are not primarily in the group under discussion, that is to say, they should not be thought of as malacic bone diseases, but inasmuch as the bone defects produced by them are so often seen by the roentgenologist and must so often be differentiated from the others, we thought it well to discuss them in this place. In this group are those bone defects that are produced by erosion as a result of pressure from other tissue, either outside or within the marrow of the bone, pressing upon the bone and eroding it very much as an aneurysm or other new growth eats away or dissolves bone in its vicinity. Because of the widespread manifestations of abnormal tissue in these diseases, we find bone defects of the skeleton which are distributed throughout the bones of the body and involve the skull and pelvic bones as well as the vertebrae, ribs and long bones many times in all of these diseases. In this group we mention Schüller-Christian's disease, Gaucher's disease, Niemann-Pick's disease and Hodgkin's disease. We all immediately, of course, recognize that these diseases are not primarily related to the bones themselves, but that the bones suffer as a result of pressure and erosion from the abnormal tissue which characterizes each of these conditions in turn. The differential diagnosis, of course, is not always easy, and the roentgenologist often finds it quite difficult to separate members of this group from various others which belong to the truly malacic classification. We might also in the same category place generalized carcinomatosis as it sometimes manifests itself in cancers of the breast, thyroid, prostate, adrenal and sometimes in other organs. Many persons would be inclined also to place in this group multiple myeloma of the bone, but as I shall mention later it is my personal belief that multiple myeloma of the bones will ultimately be found to belong to the osteitis fibrosa cystica group and to be considered merely as a malignant end-stage of that affection.

In our last group, we place all those diseases which at the present time we feel are caused by either a primary parathyroidism or at least by overactivity of the parathyroid gland brought on by some special cause. This group is of special therapeutic importance in that the evidence at present seems to point to the fact that operation and removal of some of the parathyroid glands leads, in most cases, to either com-

plete clinical cure or at least marked clinical benefit. In this group we place osteitis fibrosa, osteitis deformans or Paget's disease, leontiasis ossium, the ankylosing polyarthritis of Oppel, certainly multiple cases of giant cell tumor and possibly single giant cell tumor, and also provisionally, at least, multiple myeloma of bone of the plasma cell type. I will not enter at this time into any detailed discussion of these various diseases or into any discussion of our reasons for placing them together because I expect that all these points will be brought out during this morning's discussion. The place of osteitis fibrosa cystica generalisata as of parathyroid origin and associated with parathyroid tumor is probably completely established at this time. The position of Paget's disease or osteitis deformans is possibly still controversial, although we have material which we believe points strongly to its acceptance as a member of this group. Hamburger's work probably justifies the placing of leontiasis ossium as a special clinical type of osteitis fibrosa, and Oppel's work in Leningrad on ankylosing poylarthritis seems to give strong evidence of overactivity of the parathyroid gland in these special forms of ankylosing rheumatism. This morning's discussion will bring out considerable material both for and against the question of allowing giant cell tumor a place in this classification, but our own material as it accumulates certainly seems to justify the classification at the present time, and briefly I may say that my own study of our cases of multiple myeloma has convinced me that multiple myeloma is not a disease of the bone marrow system, that it does not come from the blood-forming cells nor is it related to them in any way, but that it is a primary osteoblastic tumor arising from the primitive osteoblasts and at present should be considered as a malignant manifestation or a malignant end-stage of osteitis fibrosa cystica. There should be considerable discussion on this point as well.

RICKETS*

By RALPH S. BROMER, M.D.
Roentgenologist to the Children's and the Orthopedic Hospitals, Philadelphia, and to the Bryn Mawr Hospital
BRYN MAWR, PENNSYLVANIA

THE subject of rickets, as it has been assigned me in this symposium, has been divided into the fetal, the infantile, and the late types. In an earlier communication before this Society, I presented the subject of infantile rickets from the standpoint of the roentgenographic changes as manifested in the long bones. To this, I can add nothing. In the brief time allotted me, it is impossible to give more than a cursory review of these three types, emphasizing their roentgen signs and characteristics and their relationship to the other malacic diseases touched upon in this symposium. For much of the material, references, etc., in this paper, I am indebted to the very comprehensive monograph of Hess.

FETAL RICKETS

Before attempting any description of fetal rickets the question must first be answered, if possible, does fetal rickets actually occur? Is there a congenital factor which makes fetal rickets possible? Schmorl, in a very detailed study of over 100 full-term and prematurely born infants, failed to find histological evidence of rachitic lesions in a single instance. Previous to this, Pommer had had the same result from his study. Kassowitz, however, believed that most cases of rickets were congenital in origin, basing his opinion on the pathological changes found in the long bones, but Hess considers that his histological criteria have been proved to be unsound.

Ylppö was one of the earlier workers who attempted to prove the existence of fetal rickets by roentgenological studies. In 88 premature infants he found roentgenographic evidence of rickets in the long bones in 5 children. He believed that these lesions had developed during intrauterine life and concluded that rickets is of fetal rather than of postfetal origin. Hess and Weinstock studied the epiphyses of 250 new-born infants and could find no roentgenographic evidence of any rachitic lesion. They did find a peculiar and unexplained tendency to cupping of the diaphyseal ends such as might be termed incipient rickets in later months, but they did not regard this as conclusive evidence of rickets. Foote believes that the beaded ribs sometimes seen in premature infants at time of birth are not due to rickets of fetal origin but rather to lack of ossification due to prematurity. According to Hess, chemical analyses of the blood of the new-born do not point to the existence of congenital rickets.

Farrell and Burt have recently reported a study of a series of 48 new-born Negro infants, in whom cupping of the long bones was found in 7; of these, unmistakable evidence of clinical rickets appeared in 4, from five to thirteen weeks after birth. A similar deformity was found roentgenographically in still-born infants, but on histologic examination no microscopical evidence of rickets could be found. When studied histologically, the cupping was believed to be due to a concave variation from the usual normal straight or convex line at the junction of the zone of proliferating cartilage and the zone of preparatory calcification. They conclude that recognizable cupping in the roentgenogram is sometimes normally present in the ends of the long bones of new-born infants, caused by a normal variation in the manner in which the zone of preparatory calcification joins the zone of proliferating cartilage.

Previous to the publication of the paper

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

of Farrell and Burt, Maxwell and Miles, in reporting on osteomalacia in China, mentioned the fact that 2 out of 3 fetuses from mothers with active osteomalacia showed curious changes about the ends of some of the long bones, especially the ulna. This at once suggested to them the possibility that this might be rachitic in origin. In 1930, Maxwell and Turnbull reported 2 cases of fetal rickets in children born from mothers who had been suffering from prolonged and untreated osteomalacia. In one of the cases, evidence of fetal rickets was only afforded by the roentgen ray, and in the other, the badly preserved condition of the bones, Maxwell says, detracted, to some extent, from the value of the evidence presented. But in 1932, he was able to confirm this evidence by an indisputable case which was carefully studied by himself from the clinical side and by Turnbull from the pathological side.

Turnbull states that the last case (1932) establishes beyond doubt the occurrence of rickets or of osteomalacia in the fetus. The fetuses from osteomalacic mothers may show a disturbance of calcification which may be osteomalacic but which cannot be differentiated histologically from that in rickets of young children. This disturbance of calcification is complicated by, and its histological evidence is to a greater or less extent obscured by, an atrophy due to diminished osteoblastic activity. Both conditions are evidently due to the food of the mothers, which was grossly deficient both qualitatively and quantitatively, being comparable to that which at the end of the great war gave rise to hunger osteomalacia in Central Europe.

This work of Maxwell and Turnbull seems to establish fetal rickets definitely as an undoubted disease. It is interesting to note that the illustrations of the roentgenograms which accompany the papers of these authors show not only cupping of the diaphyseal extremities but a distinct frayed-out appearance of the zone of preparatory calcification. This change was apparently absent in the cases studied by Hess and Weinstock, and Farrell and Burt, as they make no mention of it.

Fig. 1. Passive rickets, first stage. Generalized decalcification of the bones, swelling of the resting cartilages of the epiphyses, fraying and thinning out of the diaphyseal extremities. Slight periosteal reaction.

INFANTILE RICKETS

As in most of the diseases of infancy and childhood in which the skeleton is affected, rachitic changes are manifested to the greatest degree in the areas in which bone growth occurs. Growth in length proceeds from the epiphyses at the ends of the long bones, i.e., the endochondral areas of bone growth and the increase in width occurs in the endosteal and periosteal areas.

Infantile rickets has been divided into two types by Wimberger, the passive and the active. The former is found in severe cases, the child lying on his back and not moving his extremities due to

muscular weakness. The active type is found in children who show, in spite of the rickets, a good state of nutrition and bodily activity. The essential point of differentiation in the roentgenogram is the cupping

Fig. 2. Passive rickets changing to active, in the second stage. Healing has begun as shown by the formation of the new zone of temporary calcification and of a layer of osteoid bone at the ends of the diaphyses. Early cupping of the diaphyseal extremities can also be seen.

or spreading out of the diaphyseal ends which is found in the active type. This is an accompaniment, apparently, of muscular activity.

Roentgenographically, it is possible to divide both types into three stages covering the progress of the disease from the first roentgen signs to complete healing. The first stage includes the period from the onset of beginning skeletal changes to the first sign of healing as shown in the roentgenogram. The second stage includes the healing interval from the reappearance of the zone of temporary or preparatory calcification to the dense bone stage which is the stage of complete healing. The third stage might be called the stage of residual deformity in those cases which, in previous stages, have developed the characteristic deformities of rickets. Serial roentgenograms are necessary for the detection of the changes.

While cupping seems to be the result of muscular activity, transforming the passive into the active type, there seems to be a variety of the passive type which is of mild degree, often manifesting itself in patients who have had excellent care and supervision of their diet and proper exposure to sunlight and ultraviolet rays. Clinical signs of rickets are usually detected, such as a Harrison's groove combined with a mild rosary, and very often an increased lateral mobility of the knee joints or a true genu valgum. As a rule, on roentgen examination, no evidence of rickets can be found other than an increased density of bone with a broad, wide, dense zone of temporary calcification. No actual bowing or other deformity than the genu valgum above noted occurs in this type of case.

In the metaphysis, or the region of the end of the diaphysis, is shown the first recognizable roentgen sign, a tendency to loss of calcium and a fraying out of the normal, sharply outlined, zone of temporary calcification. This assumes a thin, broken appearance as the disease progresses. Ultimately, it may entirely disappear. The cortex becomes streaked and in the cancellous bone of the metaphysis, coarse trabecular shadows can be noted running through it in irregular fashion. In the passive type no cupping of the diaphyseal ends can be seen, but if the child is active, this sign soon appears and is found in varying degree. The calcium deposition surrounds the swollen epiphyseal cartilage, and appears as a thin line, spreading in a semicircular fashion about the resting cartilage of the epiphysis. In severe cases, fractures of the shafts may occur.

In the second stage or period of healing and repair, the zone of temporary calcification, as it reappears, is at first faint, but later becomes wider and denser. Between this and the site where the old zone of

temporary calcification was located at the beginning of the disease is a layer of homogeneous appearing bone, containing less calcium, of varying width, which is caused by the layer of osteoid bone. As repair proceeds, this gradually assumes a denser appearance. The reappearance of the zone of temporary calcification is overlooked unless serial roentgenograms are made at intervals of at least one week. If a relapse occurs (Schmorl), the new zone of temporary calcification will be broken through, and the line of temporary calcification corresponding to the period of healing will be partially or completely buried in the widened distal portion of the diaphysis. Occasionally, in the roentgenogram, several of these buried lines may be seen, indicating as many attempts at healing with relapse. In the active form the new zone of temporary calcification appears as in the passive form and the osteoid zone is also similar. The latter gradually becomes more calcified and denser until healing is complete. Since bowing of the shaft is the usual finding in the active form, thickening of the cortex on the concavity of the curve appears as a diagnostic sign. In some cases of the active form, healing is shown as a filling-up process of the cupped end from the bottom to the top of the cup by calcium deposition (Göttche). In this type of case, the formation of a new zone of temporary calcification often cannot be detected.

The dense eburnated cortex of the long bones is the characteristic appearance of the third or completely healed stage. Along with this are the thick, broad and dense zone of temporary calcification and the transverse striations or thin fine lines which run transversely through the metaphysis. The thickened cortex on the concavity of the bowed bones is dense and eburnated.

While the above changes in the metaphysis have been occurring, the disease has been progressing simultaneously in the epiphysis. In the first stage an increased width and opacity of the resting cartilage can be detected in roentgenograms showing excellent soft part detail. The centers themselves have faint or moth-eaten outlines, provided they have already appeared in the roentgenogram. The distinct limiting border of the center may be entirely absent, and its cortex may appear only as a faint haze. In mild infantile rickets, the epiphyseal centers appear in the roentgenogram without visible delay, but in moderately severe or very severe rickets no new centers appear (Plaut). They are, however, actually laid down as can be demonstrated histologically, but owing to deficient calcification, they remain invisible until healing sets in. If roentgen examinations are made after repair when calcium deposition has begun, epiphyseal centers are shown of such size as to indicate their previous existence for several months. If the rachitic process is acute, ossification centers that have been visible may become invisible owing to loss of calcium. Only in

Fig. 3. Active rickets, second stage. Cupping is prominent, new zones of temporary calcification have formed and osteoid zones are fairly well calcified.

Fig. 4. Passive rickets, final stage. The only roentgen signs are the increased density and width of the zones of temporary calcification. This patient had laxity of the capsules of the knee joints, evidence of an old mild rachitic rosary and a mild degree of pronation of the feet.

acute cases accompanied by severe disturbance of bodily development is there actual delay in the development of the centers.

In the second stage, after healing has begun, the time of reappearance of the epiphyseal centers depends upon the severity of the rachitic process. Sometimes a new zone of temporary calcification can be seen, encircling an osteoid layer of bone, just as at the diaphyseal ends. The moth-eaten centers become homogeneous and ultimately the bone regains its normal structure. It seems that the osteoid zone in the epiphyseal center usually calcifies at the same rate as the analogous layer in the end of the diaphysis. In the active form the centers broaden to meet the widened diaphyseal ends. Some show large areas which are slow in filling in with calcium. In the final stage of complete healing the centers are dense and almost eburnated similar to the appearance of the cortex of the shafts.

Periosteal changes occur in rickets manifested by a periosteal thickening along the borders of the shafts. This is difficult to distinguish from the periosteal proliferation seen in congenital syphilis. As the process advances the periosteum loses the thinly streaked or striated appearance and as osteoid bone beneath the periosteum becomes calcified the striations, horizontal with the shaft, are merged with the dense shadows of the cortex.

In the flat bones there is gradual loss of calcium salts depending upon the severity and the rate of development of the rachitic process. When the disease reaches its height, the bones present a moth-eaten, streaked appearance, resembling that of the cortex of the shafts of the rachitic long bones. Often cystic areas develop around the borders of the flat bones, especially in the scapula and the ilium. During the stage of repair, osteoid zones sometimes form around the flat bones and finally they assume the same dense and eburnated appearance seen in the fully healed shafts of the long bones.

In the skull, craniotabes is shown roentgenologically by marked thinning or total absence in isolated areas of both tables of the skull. Thin, fine lines due to fracture are often seen. As healing proceeds, the tables gradually thicken, especially in the frontal or occipital areas, and the cortex shows a thick, white and eburnated texture, forming the typical rachitic bosses. In these cases the differential diagnosis from the hypertrophic type of osteitis due to congenital syphilis is difficult. Craniotabes is usually seen in the first few months of life manifesting itself at an earlier date than the rachitic changes in the long bones.

LATE RICKETS

It has been said (Tubby) that true rickets is the only disease which proceeds to

eburnation, with arrested growth in length of the long bones, while the width and density of the bones is much increased. Thus rickets reaches its final stage about the age of five years, after which time the disease never returns, although the deformities produced by it remain. Many observers, however, do not agree with this, claiming that recrudescence may occur, that rickets may reappear from time to time and occasionally cases are seen in which obvious rachitic deformity comes on in early adolescence or even in early adult life. The first case of late rickets was apparently reported by Drewitt who in 1880 showed at the Pathological Society (London), a case of active rickets in a boy ten years of age, the diagnosis being subsequently verified post mortem. Schmorl and Pommer by their researches made it clear that rickets and osteomalacia are essentially one and the same pathological condition, the main distinction being the age of the individual. Thus late rickets occupies a position between rickets and osteomalacia, the first occurring in infants and the second in adults. It consists of an intermediate group of cases, the lower boundary of which, Hess states, was set at four years by Schmorl, with whose opinion he agrees. At the other extreme, it is more difficult to draw a line of differentiation between rickets and osteomalacia. Usually all cases up to the age of eighteen or twenty years are considered as late rickets. Under such classification would then be placed the cases which have been reported as juvenile osteomalacia. An essential but extremely difficult point in the diagnosis is the exclusion from late rickets of all cases of recrudescence and cases which have been termed rachitis inveterata.

Fig. 6. Prominent new zones of temporary calcification and osteoid zones have formed about the epiphyseal centers of the femoral heads. Second stage, active rickets.

Fig. 5. Active rickets, final stage. Bowing is marked, cortex is dense and almost eburnated, and there is marked thickening of the cortex on the concavity of the rachitic curve. The epiphyseal centers are broadening to meet the widened and previously cupped diaphyseal extremities. The zones of temporary calcification are broad and dense.

Hess divides the reported cases clinically into two main groups: a general type and a localized type. In the first, there occurs generalized pain on walking or standing. The gait becomes uncertain and waddling. Beading of the ribs may occur, and with this may be associated clinical enlargement

of the epiphyses. There may also be some deformity of the legs, genu varum or valgum, bowing of the humerus and of the forearm, scoliosis and kyphosis, clubbed fingers and, finally, after several years, stunting of the growth.

The roentgenographic appearance is much like that of infantile rickets in many cases which have been reported. Generalized osteoporosis, frayed-out appearance of the diaphyseal ends and the epiphyseal centers, coarse trabecular shadows in the metaphyses and bowing are often found. In mild cases there may be only an increased width of the clear space between the epiphysis and the end of the diaphysis. Attention has been drawn to the less marked clinical enlargement of the epiphyses in late as compared with infantile rickets, but Hess considers that Schmorl has satisfactorily explained this by the fact that the resting and proliferating cartilage of the epiphysis is much narrower at the age when late rickets develops, endochondral ossification having almost ceased at that time of life.

In the local form, isolated deformities of the long bones such as knock-knee or bow-legs have been considered by some to be due to late rickets, especially when accompanied by slight widening of the epiphyses or a slight rosary. In such instances the local deformity is regarded as a manifestation of a general process which is latent in the apparently unaffected portions of the skeleton. It is generally admitted that such cases are due to rickets. Hess thinks that the so-called deformities of adolescence which occur in patients who may have been brought up under the most favorable hygienic conditions are not to be definitely classed as late rickets inasmuch as definite proof of their rachitic origin has not yet been obtained. At present the majority of writers incline to the view that only a small number of these cases are due to rickets.

Dr. Vogt, who speaks later in this symposium, will show cases of renal rickets. The bone changes which he will describe are similar in many ways to those of the late type here described.

Relation of the Parathyroid Glands to Rickets

In his discussion of the relation of the parathyroid glands to rickets, Hess states that Erdheim made one of the first reports on the parathyroids in rickets. He studied rickets experimentally in rats and found a marked increase in the size of the parathyroids, this increase being the result of general hyperplasia of the glands and of hypertrophy of the individual cells. He regarded this hypertrophy as the result of rickets rather than as a cause. In a later study of rachitic children, he could not decide from the microscopic appearance of the parathyroids whether they had been removed from a rachitic or a non-rachitic child, but he was impressed by the fact that the glands from rachitic children were relatively large and full on microscopic examination. Ritter carried out a study in rachitic children and came to the conclusion that in prolonged and severe rickets a marked enlargement of the parathyroids comes about which seems to be associated with the period of early healing. Pappenheimer and Minor (also quoted by Hess) thought that there was a very definite increase in size of individual cells.

Hess draws attention to the fact that in none of these studies were analyses of the blood carried out and therefore it cannot be ascertained whether or not the cases of rickets were associated with low calcium and evidences of tetany. Pappenheimer (1930) concluded after experimental study that acterol is antirachitic in the absence of the parathyroids, his experiments having been performed on parathyroidectomized rats. Hess and Lewis had earlier suggested that irradiated ergosterol raised the calcium by stimulating the activity of the parathyroid glands. They found that when irradiated ergosterol was fed in large amounts to animals suffering from the low calcium type of rickets, the serum calcium promptly rose, but after the parathyroids had been extirpated, no benefit accrued. However, Shelling has found that viosterol is efficacious in raising the serum calcium level in rats after the parathyroids have been removed.

Hess summarizes the function of the parathyroids as the medium of stabilization of calcium metabolism. Rickets places a heavy burden on their activity and this may lead to hypertrophy. Thus he suggests that if rickets has lasted a long period of time, they become incapacitated and are no longer able to maintain the normal level of calcium in the body and the blood, and this finally brings about an increased irritability of the nerves.

Erdheim reported a case of parathyroid tumor with associated findings in the bones of late rickets and he pointed out the fact that where changes in the parathyroids have been found at autopsy they have been noted in the cases of the late or delayed type of rickets. Hess concludes that the subject may be summarized by the statement that the association between hypertrophy of the parathyroids and osteomalacia and tetany is definite and unquestionable but that its connection with uncomplicated rickets of the low phosphorus type remains to be substantiated, although it is probable that an interrelationship exists.

Thus, while the interrelationship of rickets and the parathyroids is probable, extirpation of the latter is not indicated from clinical and pathological studies as in the case of osteitis fibrosa cystica. Even in a case of late rickets with an associated parathyroid tumor, extirpation of the latter would likely be of doubtful benefit because large doses of viosterol have been efficacious in curing late rickets when small doses in the same cases have failed. Sufficient doses of vitamin D and phosphorus effect cures in high calcium rickets. In infantile rickets, extirpation is certainly not indicated.

I wish to thank Dr. Mitchell I. Rubin and Dr. Irvin Stein for their assistance in the preparation of the section on the relation of the parathyroids to rickets.

REFERENCES

1. Erdheim, J. Zur normalen und pathologischen Histologie der Glandula thyroidea, parathyroidea und Hypophysis. *Beitr. z. path. Anat. u. z. allg. Path.*, 1903, *33*, 158.
2. Farrell, J. T., Jr., and Burt, E. F. Nonrachitic cupping of long bones in the new-born. *J. Am. M. Ass.*, 1932, *98*, 1801–1803.
3. Foote, J. A. Clinical Pediatrics. Diseases of the Bones, Joints, Muscles and Tendons. Vol. VII. D. Appleton & Co., New York, 1927.
4. Göttche, O. Zur Röntgendiagnostik der Rachitis. *Jahrb. f. Kinderh.*, 1927, *116*, 329–337.
5. Hess, A. F. Rickets Including Osteomalacia and Tetany. Lea and Febiger, Philadelphia, 1929.
6. Hess, A. F., and Lewis, J. M. Clinical experience with irradiated ergosterol. *J. Am. M. Ass.*, 1928, *91*, 783–788.
7. Hess, A. F., and Weinstock, M. Quoted by Hess, ref. 5.
8. Kassowitz, M. Quoted by Hess, ref. 5.
9. Maxwell, J. P., and Miles, L. M. Osteomalacia in China. *J. Obst. & Gynaec. Brit. Emp.*, 1925, *32*, 433–473.
10. Maxwell, J. P., and Turnbull, H. M. Two cases of foetal rickets. *J. Path. & Bacteriol.*, 1930, *33*, 327–338.
11. Maxwell, J. P., Hu, C. H., and Turnbull, M. H. Foetal rickets. *J. Path. & Bacteriol.*, 1932, *35*, 419–440.
12. Pappenheimer, A. M. The antirachitic action of cod liver oil and irradiated ergosterol in parathyroidectomized and thymectomized rats. *J. Exper. Med.*, 1930, *52*, 805–812.
13. Pappenheimer, A. M., and Minor, J. Hyperplasia of the parathyroids in human rickets. *J. Med. Research*, 1920–1921, *42*, 391. Quoted by Hess, ref. 5.
14. Plaut, H. F. Röntgenuntersuchung über die Knochenkernbildung bei Rachitis. *Ztschr. f. Kinderh.*, 1924, *38*, 540–556.
15. Pommer, G. Untersuchungen über Osteomalacie und Rachitis. Leipzig, 1885. Quoted by Hess, ref. 5, and Maxwell and Turnbull, ref. 10.
16. Schmorl, G. Ueber Rachitis tarda. *Deutsches Arch. f. klin. Med.*, 1906, *85*, 170. Also: Die pathologische Anatomie der rachitischen Knochenerkrankung, etc. *Ergebn. d. inn. Med. u. Kinderh.*, 1909, *4*, 403.
17. Shelling, D. H. Calcium and phosphorus studies. II. The effect of diet and viosterol on tetany and on the serum calcium of parathyroidectomized rats. *J. Biol. Chem.*, 1932, *96*, 215–228.
18. Tubby, A. H. Deformities Including Diseases of the Bones and Joints. Macmillan and Co., London, 1912.
19. Ylppö, A. Das Wachstum der Frühgeborenen von der Geburt bis zum Schulalter. *Ztschr. f. Kinderh.*, 1919, *24*, 111. Quoted by Hess, ref. 5.

OSTEOMALACIA*

A BRIEF REVIEW OF THE MODERN CONCEPTION OF THE DISEASE

By PAUL C. HODGES, PH.D., M.D., *and* ALFRED C. LEDOUX, M.D.
CHICAGO, ILLINOIS

TERMINOLOGY

THE term "osteomalacia" is literally applicable to all of the diseases included in this symposium but tradition restricts its use to the particular softening of spine, pelvis and extremities that sometimes occurs in pregnant or lactating women.

The fundamental process is probably identical with the rickets of children where growth plays an important rôle but the special calcium demand of pregnancy or lactation is absent, and with senile or famine osteoporosis where diet deficiency is the sole factor. Much less close is the relationship to the osteoporosis that follows primary parathyroid disease or dysfunction, to Paget's disease or to osteitis fibrosa cystica.

Physiologists are not inclined to be dogmatic in statements dealing with the function of the parathyroids but at least there is agreement in the belief that these tiny structures are intimately concerned in the metabolism of calcium and that certain parathyroid tumors produce decalcification of the pelvic bones practically identical with that seen in the osteomalacia of childbearing women.[6,12,20] Furthermore, diets that will probably produce osteomalacia in animals if continued long enough do frequently cause enlargement of the parathyroids.[36,38,39] Some have interpreted these facts as proof that osteomalacia is a parathyroid disease. The opposing view, which we support, considers that in osteomalacia parathyroid action is merely incidental, diet deficiency the active agent.

We wish to acknowledge that except for the fact that one of us was associated formerly with Maxwell in Peiping and did most of the roentgenographic work connected with his earlier publications,[43] our knowledge of the subject is drawn entirely from the references listed, particularly from the splendid review by Park,[52] the monograph by Hess[23] and the lectures of Trousseau,[62] the latter having been brought to our attention by Franklin McLean and loaned to us from his private library.

RICKETS

Since osteomalacia is the rickets of adults it will be well to review briefly the development of knowledge of that better known condition.

Glisson in 1650 recognized the disease as a distinct entity. Trousseau in 1849 understood its similarity to osteomalacia and knew how to treat it with cod-liver oil. Pommer in 1885 described the microscopic picture of the disease. Palm[51] in 1890 had a clear understanding of the rôle of sunlight in rickets but his publication made little impression on the medical opinion of his time. Buchholz[5] in 1905 attempted to treat rachitic children with artificial light but was not successful and his work was not generally known. Hopkins[25] and von Hansemann[21,22] in 1906 appreciated the fact that minute elements in the diet and an abundance of outdoor light were essential to health while their absence produced rickets. This view was advanced again in 1914 by Funk[18] but meanwhile Findlay,[14,15,16] working in Glasgow in 1909, concluded that the rickets he was able to produce in puppies was due to lack of exercise. Mellanby[47,48,49] in 1918 convinced himself that rickets is primarily a deficiency disease and though he was mistaken in his opinion as to the exact nature of the deficiency, Park credits him with turning scientific opinion into the channels which

* From the Division of Roentgenology, Department of Medicine, University of Chicago. Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

it has followed ever since. Huldschinsky[28] in 1919 published conclusive evidence to show that under certain conditions the radiation produced by a mercury arc quartz lamp will produce calcification and healing in the lesions of rickets.

Cod-liver oil had been used empirically for many years[62] in the treatment of rickets but Park and his associates, publishing in 1921, were the first to present experimental evidence of its usefulness. Their demonstration of calcification and healing in the cartilages of rachitic rats led to the development of a technique for the biological standardization of the oil, which has been of tremendous importance both in the clinical use of the oil and in a clearer understanding of the disease on which it exerts a truly miraculous effect.

Steenbock and Black[59] in 1924 published their paper entitled "The induction of growth-promoting and calcifying properties in a ration by exposure to ultra-violet light" and the newer knowledge on irradiated ergosterol that followed is too recent and too generally known to require further consideration here.

PATHOLOGY OF OSTEOMALACIA

In spite of Trousseau's[62] insistence that rickets and osteomalacia were essentially identical and his proof that both might be cured by the administration of cod-liver oil, the fact was not generally accepted. On the contrary, Virchow was presently teaching that the two diseases were quite different because in the one newly forming bone failed to calcify and, in the other, bone that had once been well calcified lost its calcium probably due to a leaching action of excess acid in the blood. Cohnheim in 1889 revolutionized bone physiology by demonstrating that skeletal tissue like all other tissue is constantly being destroyed and reformed, and McCrudden,[46] in the light of this concept, restudied the osteomalacia problem in 1908 and enunciated a "new pathology" which is generally accepted at this date, a quarter of a century later.

McCrudden's careful work stands out as some of the finest of the osteomalacia literature. He proved by philosophical reasoning as well as by laboratory experiments that the hyperacidity theory was untenable and he uncovered some of the chemical errors that had contributed to this faulty concept of the disease. Clinical and experimental data were marshalled to destroy the idea that ovarian action was intimately connected with the malady and that castration offered a cure. Microscopic and chemical studies were interpreted as showing that the physiological destruction of old bone and its replacement by new osteoid tissue went forward in a normal fashion but for some reason the calcium liberated from the old bone was not utilized by the organism to calcify the new osteoid tissue but instead was lost from the body, principally in the feces.

DIAGNOSIS

The late stages of osteomalacia, marked by gross distortion of the female pelvis, are not apt to be missed at physical examination, and since in most cases of this sort the disease is no longer active and recalcification has occurred, roentgenograms are easily made and easily interpreted.

The active stage is extremely rare in the United States and most of Europe and this fact alone undoubtedly tends to make physicians fail to recognize the occasional cases that may come their way. In China,[41] India,[55] and certain parts of Europe, however, active cases are being uncovered in increasing numbers and where the condition is suspected diagnosis is not difficult. There is pelvic pain ranging from a dull backache to intense pain on the slightest movement. Gait may be disturbed only to the extent that the subject walks with a characteristic waddle or the disturbance may be so severe that the recumbent patient cannot feed herself, much less stand or walk. The calcium and phosphorus content of the blood is usually but not invariably disturbed, the stool almost always contains an excess of calcium, and roentgenograms show an unmistakably gross

alteration in the appearance of spine, pelvis and sometimes femora and other long bones.

The pelvic cortex is paper-thin, the trabeculae are seen as a faint network of extremely fine lines and there are apt to be multiple fractures of the pelvic bones. Because of the softness of the bone these fractures lack the angular, brittle appearance of a traumatized pelvis of normal density and the lesions are better described as a crumpling of the pelvis.

DISTRIBUTION

The "osteomalacia areas" described in the Western Europe of two decades ago and considered proof of the relationship between this disease and local conditions of food, water or exposure to infection are little talked of today, and the earlier belief that there were similar sharply restricted disease zones in India and China is falling before the modern conception that the disease occurs whenever and wherever conditions of light and vitamin D deficiency in the presence of increased calcium demand are sufficiently unfavorable.

THE DISEASE IN ANIMALS

In the course of methodical studies on the relationship between food intake and the farm production of milk, eggs and meat, Steenbock[56] in 1912 took up the study of the rôle of lime in the diet. He knew that pregnant animals lost calcium in the urine and feces and that it collected in the meconium of their fetuses and he was curious as to why these animals did not reabsorb the calcium and retain it. He was not at all impressed with the prevailing ideas that the fecal calcium was not in a suitable chemical state for reabsorption but postulated rather that the passage of calcium into the intestine was a normal affair and that for some reason pregnancy interfered with the organism's ability to reabsorb and utilize the calcium, as he supposed was probably done in the normal nonpregnant or nonlactating state. (We now know that this is the case—that an animal ingesting barely enough vitamin D for her own metabolic needs will supply a portion of this to her fetus, thus becoming deficient herself and therefore unable to accomplish adequate metabolism of calcium.) The work was begun by confining a cow to a metabolism cage, determining the exact amount of calcium in all forms in her diet and then reducing that calcium until an interference with metabolism occurred. This was followed shortly by a similar experiment with a lactating goat confined in a metabolism cage from April 4 to July 29, 1912, on a diet consisting of oat straw, wheat bran and meal from corn rice and gluten. This was gradually modified until by June 12 oat straw alone was being fed and the calcium content of the diet was rather low. The animal gradually showed signs of disturbed metabolism, lactation ceased, alertness was reduced and calcium was lost in the feces steadily. There were no clean-cut symptoms of osteomalacia and the stiffness of the hind quarters may have been due merely to confinement in the cage but Steenbock, whose experience ought to make him a competent judge, considered that a continuation of the experiment would have led to osteomalacia.

With the idea of allowing the animal a temporary respite, calcium intake was increased to the level used during the opening days of the experiment but surprisingly no improvement occurred and on the thirtieth of July it was deemed necessary to discontinue the experiment.

After two weeks of grazing on green grass with supplementary feedings of oats the animal was restored to apparently perfect health and Steenbock in this article, written before the publication of Funk and the work of Mellanby, reached conclusions, the essentials of which may be summarized as follows:*

This animal brought to a condition which would have led to osteomalacia has been completely restored to normal by a temporary

* Steenbock's actual words rearranged and condensed for brevity.

change in diet. That the change of intake of lime was responsible is out of the question. Some subtle variation in feed intake and environment now enables the animal to assimilate lime formerly unavailable. Just what these factors are we cannot venture to say.

The fowls reported by Marine[39] in 1914, Luce's[36] 1923 rats and Macomber's[38] 1927 rats were fed diets deficient in calcium and did not develop osteomalacia or rickets of the grade that Luce could see on examination by the naked eye or Macomber with the aid of roentgenographic examination. It must be remembered, however, that none of these animals or birds were deliberately deprived of sunlight and that the earlier ones at least had no control of the vitamin D content of their diet. It is hard to believe that no one has conducted the obvious experiment of holding pregnant monkeys on diets known to be capable of producing rickets in growing animals but we have been unable to find any record of such work.

White's 1922 article[64] on osteomalacia among monkeys in the Philadelphia Zoo impresses us as a pretty convincing illustration of the etiology of the disease.

RELATIONSHIP OF RICKETS TO OSTEOMALACIA

Most of the arguments against the identical nature of these diseases are based on negative evidence. It is claimed, for instance, that certain conditions of diet and light in China produce osteomalacia in a high percentage of child-bearing women but fail to produce rickets in children living under identical conditions. Indian women confined to dark quarters by the requirements of their religion and restricted to inadequate diet by poverty or ignorance suffer from osteomalacia but children said to be on diets at least as bad survive in the same community without acquiring rickets. Such arguments are easily attacked from two sides. First, the statement that conditions of diet and light are identical in any two cases can be accepted only after painstaking investigation. Second, a report to the effect that this disease or that does not exist in a certain territory is usually worthless. Rickets "did not exist" in China until Franklin McLean in about 1920 put Ernest Tso to work looking for it. There is no dearth of Chinese rickets now.

FETAL RICKETS AND OSTEOMALACIA

Another stumbling block has been the supposed absence of instances of fetal rickets in children born by caesarean section from women suffering from active osteomalacia.

A low incidence of such cases would not be surprising because of the recognized ability of the fetus to obtain all of the materials necessary for its metabolism at the expense of the maternal organism. Occasional cases should be encountered, however, where the maternal metabolic deficiency is so severe that the fetus does not escape rachitic lesions. In 1929 there seemed to be no proved case of this sort but Maxwell, Hu and Turnbull[45] have recently described and illustrated a case of undoubted rickets in the caesarean child of a mother suffering from frank osteomalacia.

TREATMENT

The treatment of osteomalacia is the treatment of rickets—a diet adequate in all respects and particularly in vitamin D, plus an adequate amount of sunshine. Early failures to cure by this method are now recognized as due to the administration of an inadequate amount of cod-liver oil at a time when its biological standardization was not well understood. As Hess points out, blockaded central Europe in spite of the exigencies of war had close at hand all of the necessary medicines to cure the war osteomalacia. Yeast was available and sunlight, either natural or artificial, but at that time the human race had not learned to put the two together and thus produce a material essential in the metabolism of calcium. Future work may well demonstrate that diet deficiency depletes skeletal calcium through the agency of the

parathyroids but even if this can be shown to be true the fact remains that osteomalacia is primarily a disease manifestation of vitamin D deficiency.

REFERENCES

1. Barr, D. P., Bulger, H. A., and Dixon, H. H. Hyperparathyroidism. *J. Am. M. Ass.*, 1929, *92*, 951–952.
2. Blum, L., Delaville, and Van Caulaert. Minerals in blood in osteomalacia. *Compt. rend. Soc. de biol.*, 1924, *91*, 599–601. Abs. *J. Am. M. Ass.*, 1924, *83*, 877.
3. Blumgart, H. L., Cargill, S. L., and Gilligan, D. R. Osteomalacia; a study of its metabolism and treatment. *Tr. Ass. Am. Physicians*, 1929, *44*, 245–253.
4. Boyd, J. D., Milgram, J. E., and Stearns, G. Clinical hyperparathyroidism. *J. Am. M. Ass.*, 1929, *93*, 684–688.
5. Buchholz, E. Ueber Lichtbehandlung der Rachitis und anderer Kinderkrankheiten. *Verhandl. d. Versamml. d. Gesellsch. f. Kinderh . . . deutsch. Naturf. u. Aerzte*, 1905, *21*, 116. Quoted by Park, ref. 52.
6. Compere, E. L. Bone changes in hyperparathyroidism. *Surg., Gynec. & Obst.*, 1930, *50*, 783–794.
7. Crooks, J. Two unusual examples of osteogenesis imperfecta. *Brit. M. J.*, 1932, *1*, 705.
8. Dalyell, E. J., and Chick, H. Hunger-osteomalacia in Vienna, 1920. I. Its relation to diet. *Lancet*, 1921, *2*, 842–849.
9. Dieckmann, W. J. Osteomalacia in pregnancy. *J. Missouri M. Ass.*, 1930, *27*, 451–452.
10. Dieckmann, W. J. Osteomalacia in pregnancy. *Am. J. Obst. & Gynec.*, 1932, *23*, 478–488.
11. Dock, George. Osler's Modern Medicine, Vol. 5, p. 859, Lea and Febiger, Philadelphia, 1927.
12. Dragstedt, L. R. The physiology of the parathyroid glands. *Physiol. Rev.*, 1927, *7*, 499–530.
13. Dwyer, H. L., and Eckelberry, O. S. Osteomalacia in children; a study of the mineral metabolism. *Am. J. Dis. Child.*, 1926, *31*, 639–653.
14. Findlay, L. Rickets, a historical note. *Glasgow M. J.*, 1919, *91*, 147. Quoted by Park, ref. 52.
15. Findlay, L. A review of the work done by the Glasgow School on the aetiology of rickets. *Lancet*, 1922, *1*, 825–831. Quoted by Park, ref. 52.
16. Findlay, L., Paton, D. N., and Sharpe, J. S. Studies in the metabolism of rickets. *Quart. J. M.*, 1920–1921, *14*, 352.
17. Fowweather, F. S. Some remarks on osteomalacia with special reference to a recent case. *Lancet*, 1926, *1*, 1082–1083.
18. Funk, C. Die Vitamine, ihre Bedeutung für die Physiologie und Pathologie. J. F. Bergmann, Wiesbaden, 1914. Quoted by Park, ref. 52.
19. Geschickter, C. F., and Copeland, M. M. Tumors of Bone. American Journal of Cancer, 1931, pp. 679–681.
20. Guy, C. C. Tumors of the parathyroid glands. *Surg., Gynec. & Obst.*, 1929, *48*, 557–565.
21. von Hansemann, D. Ueber Rachitis als Volkskrankheit. *Berl. klin. Wchnschr.*, 1906, *43*, 249–254. Quoted by Park, ref. 52.
22. von Hansemann, D. Der Einfluss der Domestikation auf die Krankheiten der Tiere und der Menschen. *Wien. med. Presse*, 1906, *47*, 1130–1132. Abs. *Berl. klin. Wchnschr.*, 1906, *43*, 629. Quoted by Park, ref. 52.
23. Hess, A. F. Rickets Including Osteomalacia and Tetany. Lea and Febiger, Philadelphia, 1929.
24. Holmes, G. W. Osteomalacia; its roentgenographic appearance and classification. Am. J. Roentgenol. & Rad. Therapy, 1918, *5*, 507–512.
25. Hopkins, F. G. The analyst and the medical man. *Analyst*, 1906, *31*, 385. Quoted by Park, ref. 52.
26. Hoyle, J. C. The relation of the parathyroid glands to disorders of bones. *Practitioner*, 1930, *124*, 532–547.
27. Hughes, T. A., Shrivastava, D. L., Sahai, P. N., and Malik, K. S. Further observations on the serum calcium and plasma cholesterol in health and disease and on the blood chemistry in osteomalacia. *Indian J. Med. Research*, 1930, *18*, 517–526.
28. Huldschinsky, K. Heilung von Rachitis durch künstliche Höhensonnen. *Deutsche med. Wchnschr.*, 1919, *45*, 712.
29. Hume, E. M., and Nirenstein, E. Comparative treatment of cases of hunger-osteomalacia in Vienna, 1920, as out-patients with cod-liver oil and plant oil. *Lancet*, 1921, *2*, 849–853.
30. Hutchison, H. S., and Stapleton, G. Late rickets and osteomalacia. *Brit. J. Child. Dis.*, 1924, *21*, 18–33; 96–106.
31. Kerl, F. Hyperplasia of the parathyroids in osteomalacia and osteoporosis. *Deutsche med. Wchnschr.*, 1925, *51*, 1271–1273. Abs. *J. Am. M. Ass.*, 1925, *85*, 936.
32. Knaggs, R. L. On osteitis deformans (Paget's disease) and its relation to osteitis fibrosa and osteomalacia. *Brit. J. Surg.*, 1925–1926, *13*, 206–237.
33. Laffont, A., and Sesini, M. L'ostéomalacie à la maternité d'Alger. *Rev. franc. de gynéc. et d'obst.*, 1930, *25*, 430–434.

34. Locke, E. A. Osteomalacia (juvenile form). *Med. Clin. N. Am.*, 1923, *7*, 687–704.
35. Locke, E. A. Osteomalacia. Oxford Medicine, Oxford University Press, 1927, p. 462.
36. Luce, E. M. The size of the parathyroids of rats, and the effect of diet deficiency of calcium. *J. Pathol. & Bacteriol.*, 1923, *26*, 200–206.
37. MacCallum, W. G. A Textbook of Pathology. Third edition. W. B. Saunders, Philadelphia.
38. Macomber, Donald. Effect of a diet low in calcium on fertility, pregnancy and lactation in the rat. *J. Am. M. Ass.*, 1927, *88*, 6–11.
39. Marine, David. Parathyroid hypertrophy and hyperplasia in fowls. *Proc. Soc. Exper. Biol.*, 1914, *11*, 117.
40. Maxwell, J. P. Osteomalacia in China. *China M. J.*, 1923, *37*, 625–642.
41. Maxwell, J. P. Osteomalacia in China. *China M. J.*, 1924, *38*, 349.
42. Maxwell, J. P. Further studies in osteomalacia. *Proc. Roy. Soc. Med.* (*Sect. Obst. & Gynaec.*), 1930, *23*, 19–32.
43. Maxwell, J. P. Osteomalacia and foetal rickets. *Brit. J. Radiol.*, 1930, *3*, 375–379.
44. Maxwell, J. P., and Miles, L. M. Osteomalacia in China. *J. Obst. & Gynaec. Brit. Emp.*, 1925, *32*, 433–473.
45. Maxwell, J. P., Hu, C. H., and Turnbull, H. M. Foetal rickets. *J. Pathol. & Bacteriol.*, 1932, *35*, 419–440.
46. McCrudden, F. H. Studies of bone metabolism, especially the pathological process, etiology and treatment of osteomalacia. *Arch. Int. Med.*, 1910, *5*, 596–630.
47. Mellanby, E. The part played by an "accessory factor" in the production of experimental rickets. *J. Physiol.*, 1918, *52*, 11–12. (*Proc. Physiol. Soc.* Jan. 26, 1918, p. xi.)
48. Mellanby, E. An experimental investigation on rickets. *Lancet*, 1919, *1*, 407.
49. Mellanby, E. Experimental Rickets. London, 1921, H. M. Stationary Office. (Privy Counc. Med. Res. Counc. Spec. Rep. Ser. No. 61.) Quoted by Park, ref. 52.
50. Miles, L. M., and Feng, C. T. Calcium and phosphorus metabolism in osteomalacia. *J. Exper. M.*, 1925, *41*, 137–157.
51. Palm, T. A. The geographical distribution and aetiology of rickets. *Practitioner*, 1890, *45*, 270–291; 321–342.
52. Park, E. A. Etiology of rickets. *Physiol. Rev.*, 1923, *3*, 106–163.
53. Pilley, V. E. An x-ray study of osteomalacia *Indian J. Med. Research*, 1929, *17*, 348–350.
54. Richardson, E. P., Aub, J. C., and Bauer, W. Parathyroidectomy in osteomalacia. *Ann. Surg.*, 1929, *90*, 730–741.
55. Stapleton, G. Late rickets and osteomalacia in Delhi. *Lancet*, 1925, *1*, 1119–1123.
56. Steenbock, H., and Hart, E. B. The influence of function on the lime requirements of animals. *J. Biol. Chem.*, 1912–1913, *14*, 59–73.
57. Steenbock, H., and Nelson, E. M. Fat-soluble vitamins; light in its relation to ophthalmia and growth. *J. Biol. Chem.*, 1923, *56*, 355–373.
58. Steenbock, H., Hart, E. B., Sell, M. T., and Jones, J. H. The availability of calcium salts. *J. Biol. Chem.*, 1923, *56*, 375–386.
59. Steenbock, H., and Black, A. Fat-soluble vitamins; the induction of growth-promoting and calcifying properties in a ration by exposure to ultra-violet light. *J. Biol. Chem.*, 1924, *61*, 405–422.
60. Steenbock, H., Black, A., Nelson, E. M., Nelson, M. T., and Hoppert, C. A. Antirachitic activation by light. *J. Biol. Chem.*, 1925, *63*, xxv.
61. Stone, E. L. A brief review of the literature of osteomalacia with the report of a case necessitating delivery by caesarean section. *Surg., Gynec. & Obst.*, 1924, *39*, 599–609.
62. Trousseau, A. Lectures on Clinical Medicine. Translation by John Rose Cormack. The New Sydenham Society, London, 1872, Vol. V, p. 81.
63. Vaughan, K. Osteomalacia in Kashmir. *Brit. M. J.*, 1926, *1*, 413–415.
64. White, E. P. C. Osteomalacia. *Arch. Int. Med.*, 1922, *30*, 620–628.
65. Wilder, R. M. Hyperparathyroidism; tumor of the parathyroid glands associated with osteitis fibrosa. *Endocrinology*, 1929, *13*, 231–244.
66. Wilson, D. C. Osteomalacia (late rickets) studies; clinical symptoms in relation to bone changes as shown by x-ray examination. *Indian J. Med. Research*, 1929–1930, *17*, 339–347.
67. Wilson, D. C., and Coombes, W. K. Osteomalacia (late rickets) studies; factors in treatment. *Indian J. Med. Research*, 1930–1931, *18*, 959–962.
68. Wilson, D. C., and Patel, G. P. Osteomalacia (late rickets) studies; blood picture. *Indian J. Med. Research*, 1929–1930, *17*, 881–887.
69. Wilson, D. C., and Surie, E. Osteomalacia (late rickets) studies; dietary factors in the aetiology of osteomalacia. *Indian J. Med. Research*, 1930, *17*, 889–902.
70. Wyatt, H. G. Notes on osteomalacia in North China. *China M. J.*, 1930, *44*, 1168–1182.

OSTEITIS FIBROSA CYSTICA

ASSOCIATED WITH PARATHYROID OVERACTIVITY*

By RICHARD DRESSER, M.D.
BOSTON, MASSACHUSETTS

CASES of osteitis fibrosa cystica may be divided into two groups: first, those unassociated with an endocrine disturbance and usually of obscure etiology; second, those which are a manifestation of a systemic disease caused by overactivity of the parathyroid glands. This paper will deal only with the latter group.

It was shown first by MacCallum that hypofunction of the parathyroids resulted in tetany, the symptoms of which could be relieved by the administration of calcium. The fact that these glands exercise a control over calcium metabolism was thus established.

Overactivity of the parathyroids produces a condition which is the reverse of tetany. This is characterized by an increase in the calcium content of the blood, a lowering of the blood phosphorus, an increased elimination of calcium and phosphorus by the kidneys, and a decalcification of the bones. This condition can be produced experimentally in animals by the administration of parathyroid extract (parathormone) and is observed in man in certain cases of osteitis fibrosa cystica. It was not until 1926 that Mandl definitely established the relationship of parathyroid dysfunction to osteitis fibrosa cystica by the removal of a parathyroid adenoma. The operation was followed by a most remarkable improvement in the patient's condition. Since this pioneer work by Mandl an increasing number of similar cases successfully operated upon are appearing in the literature.

SYMPTOMS OF HYPERPARATHYROIDISM

The disease may occur at any age, and in either sex, but is most common in women between thirty and sixty. Most patients complain first of bone and joint pains which they attribute to "rheumatism." In the advanced stages of the disease extensive skeletal deformities may develop as the result of softening, bending, and fracture of the bones. Gastrointestinal symptoms are not uncommon, such as loss of appetite, nausea, and occasionally vomiting. There is usually a slow, progressive loss of weight, and a secondary anemia. There may be a palpable tumor in the neck (parathyroid adenoma).

The urinary symptoms are important. There is impairment of renal function. Polyuria is frequently present, with low specific gravity, albumin, and casts. The increased output of calcium and phosphorus leads to the formation of urinary calculi, which may be bilateral. *Any abnormal rarefaction of one or more bones in a patient presenting a renal calculus should be regarded as suspicious of osteitis fibrosa cystica* (Case IV).

A correct determination of the blood calcium and phosphorus is essential to the diagnosis. The serum calcium is elevated (more than 10 mg. per 100 c.c.), and the serum inorganic phosphorus is low (less than 4 mg. per 100 c.c.).

PATHOLOGY

The skeletal changes are characterized by decalcification and cyst formation which have been described at length in an earlier article.[2] Specimens removed from the cystic areas give the microscopic appearance of benign giant cell tumor.

The parathyroid tumors which have been described vary in size from a few millimeters to 5 or 6 centimeters in diameter. The microscopic picture is that of an adenoma which may be difficult to differentiate from normal parathyroid tissue.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

Abnormal calcium deposits in the soft tissues have been described.

ROENTGEN FINDINGS

The skeletal changes are: (1) generalized bone decalcification together with localized areas of increased bone density; (2) generalized or localized cyst formation. It must be emphasized that not all cases present a typical picture. A generalized osteoporosis may be seen without cyst formation, and, conversely, cyst formation may occur without appreciable osteoporosis.

When the skull is involved the picture is fairly characteristic and should point the way to the correct diagnosis. The bones of the vault present a mottling which is the result of small, irregular areas of bone condensation alternating with areas of rarefaction. In advanced stages of the disease the cranial bones may become much thickened. The upper and lower jaws are both favorite sites for cyst formation. The teeth are often carious and abscessed.

The spine may show abnormal curvatures which become more pronounced as the disease progresses. There is narrowing of the vertebral bodies with an alteration in bony texture and a tendency toward concavity of the articular surfaces. The intervertebral spaces are not narrowed and the vertebral processes do not appear abnormal.

The pelvis is frequently the site of very extensive cystic changes, and abnormalities of contour develop as the weakened bones give way to the body weight.

The ribs are quite regularly involved in the cystic process, and late in the disease there may be a caving in of the thorax with serious cardiac and respiratory embarrassment.

Cysts occur in all the long bones and in the bones of the hands and feet. The bones may become expanded and the cysts trabeculated, giving the appearance of a giant cell tumor, or there may be localized areas in which there is a complete loss of bone trabeculae, but without expansion or other alteration in the contour of the bone. In a boy of fifteen there were observed areas of increased bone density about 1 cm. in diameter extending across the diaphyses just back of the epiphyseal lines. Adjacent to these bands of condensation were areas of superficial cortical erosion. Slipping of the epiphyses has been reported in young individuals. Fractures of the extremities are common and seem to heal readily, but without excess of callus. A cyst which has been the site of spontaneous fracture or surgical interference will often regress rapidly.

Films of the abdomen show renal calculi in a large percentage of cases. These are frequently bilateral. Varying degrees of hydronephrosis are demonstrable in pyelograms.

The calcium deposits which have been described post mortem in the lungs and other viscera should be demonstrable by roentgen examination, but we have not observed them in our series.

It is our opinion that too sharp a distinction should not be drawn between localized and generalized osteitis fibrosa cystica. One of our cases presents a localized cystic change in one ilium, a renal calculus, an elevated blood calcium, and a low blood phosphorus. There are no cysts elsewhere in the skeleton, and there is no evidence whatever of generalized osteoporosis. This patient undoubtedly has hyperparathyroidism, the only roentgen evidence of which is a renal stone and a single cyst.

DIFFERENTIAL DIAGNOSIS

Two cases of multiple myeloma have recently come to our attention presenting bone changes which might easily be confused with those of osteitis fibrosa cystica. Both cases, however, presented a normal blood calcium and phosphorus and the removal of a specimen of bone established a diagnosis of myeloma beyond question.

Jores reports 2 cases of multiple myeloma showing elevation of blood calcium. In one of these cases the blood phosphorus was at first normal and later became lowered. In the second case the phosphorus was normal.

It becomes evident that the differentiation between osteitis fibrosa cystica and multiple myeloma may occasionally be extremely difficult without a pathological examination. We should recommend that a biopsy be taken from the bone whenever it is feasible.

TREATMENT

In those cases presenting a palpable adenoma of the parathyroid the surgical removal of the tumor is usually simple and is followed promptly by a return of the calcium and phosphorus balance to normal, with a rapid improvement in the patient's condition (Cases I and V). When there is no tumor felt in the neck, an exploratory operation is justifiable provided the diagnosis of hyperparathyroidism has been established beyond doubt. Such operations are occasionally unsuccessful, even when carried out by the most competent surgeons (Cases II and III). For the operative technique one should refer to the article by Hunter and Turnbull.

Albright et al. have obtained encouraging results by the administration of large amounts of phosphate. They state that, "The net result of ingestion of phosphate in hyperparathyroidism is the tendency to produce a positive balance of calcium phosphate and the altering of the serum calcium and phosphorus values in the direction of normal." They point out, however, that there are two real dangers associated with phosphate ingestion in hyperparathyroidism; first, a shut down of kidney function; second, an increased tendency toward the formation of urinary calculi.

High voltage roentgen irradiation has proved highly efficacious in relieving the pain in one of our cases (Case IV), and may have had something to do with the improvement noted in Case II. In our experience, irradiation must still be considered as a palliative measure only in this disease.

Case I. (Memorial No. 11616. Baker No. 1423.) (Previously reported.) Female, aged forty-four, white, married; first seen in September, 1930.

The patient complained of rheumatism with pain and swelling of the right forearm. There had been a slow loss of strength for a period of several years with more or less generalized "rheumatic" pains. In the past two years she had lost 20 pounds in weight. For two months she had frequency of urination. Fourteen years ago she first noticed a swelling in the region of the thyroid on the right side. The salient point of the physical examination was a palpable mass in the region of the right lobe of the thyroid. Roentgen examination showed an extensive osteitis fibrosa cystica of the skull, spine, ribs, pelvis, and bones of the extremities. There were no renal calculi. There was a spontaneous fracture through a cyst in the right ulna. The blood calcium was 11 mg. per 100 c.c., and the blood phosphorus 2.3 mg. per 100 c.c. The specimen removed from the cyst in the ulna for microscopic examination showed the picture of benign giant cell tumor.

The patient was operated on in December, 1930, and a large parathyroid adenoma removed, measuring about 6 cm. in diameter. Following the operation the blood calcium and phosphorus returned to normal. At the present writing the patient is symptomatically well. A recent roentgen examination of the skeleton shows that there is still some osteoporosis and that the cysts are very little changed in appearance, with the exception of the one in the ulna which has almost completely healed.

Case II. (M.G.H. No. 184237. Baker No. 7727.) Female, aged forty-one, white, married. (Previously reported.) Admitted to the Massachusetts General Hospital in July, 1930, with the complaint of rheumatism.

The present illness began five years previously, following the birth of the fifth child. There was weakness and pain in the back and knees. This became progressively worse until patient finally had to get about on crutches. She suffered a fracture of the hip and of the arm.

Physical examination showed general muscular weakness and tenderness on pressure of practically all the bones. Examination of the blood showed a secondary anemia. Urine examination showed a low specific gravity with albumin and many white blood cells. The blood serum calcium was elevated to 13.5 mg. per 100 c.c. and the blood phosphorus was 2.16 mg. per 100 c.c. Roentgen examination showed a generalized osteitis fibrosa cystica involving the

skull, spine, pelvis, shoulder girdles, ribs, and bones of the extremities. There were bilateral renal calculi and bilateral hydronephrosis. The patient was operated on in September, 1930, and the two lower parathyroid glands removed. These glands were not abnormal on histological examination and there was no evidence of adenoma. Following the operation there was no appreciable change in the patient's general condition. The blood calcium remained high and the phosphorus low. Patient was then given high voltage roentgen irradiation to the neck, and was put on a dietary regimen (high phosphate ingestion) which has been described by Albright and his coworkers. Follow-up roentgen examinations showed some deposition of lime salt in the bones and a tendency toward filling in of the cystic areas. The patient also obtained some symptomatic relief. There has been a progressive impairment of renal function and the patient has just been admitted to the Massachusetts General Hospital for a second surgical exploration of the neck.

Case III. (Memorial No. 13727.) Female, aged thirty-five, white, married.

The patient was referred for roentgen examination in October, 1931, with the complaint of rheumatism in the left hip. In 1926 the patient noticed pain in the left arm especially in damp weather. This continued off and on until 1930, when suddenly she could not lift her arm. The disability gradually cleared up and now she notices only pain and a tired feeling in the arm on damp days. In 1926, there was a question of an abscess in the throat. There was considerable swelling thought to be connected with the thyroid until pus was discharged and the swelling disappeared. In January, 1931, the patient fell on the ice striking on the left buttock. She was able to walk home, but remained lame and sore for two weeks. The lameness recurred every few days and the leg felt very tired. During the last three months the lameness has increased and the patient feels as if she had no strength in the left leg. During the past month the patient has noticed a swelling of the left lower jaw which she attributes to an ulcerated tooth. The family history is not remarkable. There is nothing of particular importance in the past history. The patient was pregnant about four years ago, but had a miscarriage. There have been no other pregnancies or miscarriages.

Physical examination. The eyes, ears and nose are negative. The teeth are in poor condition. There is a noticeable swelling of the left mandible which is slightly tender on pressure. The throat is a little injected. There are no masses palpable anywhere in the neck. The chest is negative to percussion and auscultation. The heart sounds are regular and of good quality. The blood pressure is 130/100. There is some soreness on pressure over the upper portion of the left thigh. The extremities are otherwise not remarkable. Present weight 141 pounds. Weight six months ago, 154 pounds.

Roentgen examination of the entire skeleton. There is general rarefaction of all the bones with cyst formation in the wing of the right ilium and in the left ilium adjacent to the acetabulum. There is also a large cyst in the upper end of the left humerus and a smaller one in the right humerus. There is a cystic area in the left patella. There is slight roughening along the margins of the terminal phalanges of the fingers. Examination of the jaws shows multiple apical abscesses and a large cystic area of bone destruction in the left mandible. The skull presents fine mottled areas of decreased density interspersed with areas of increased density throughout the bones of the vault. A film of the chest is negative. A flat film of the abdomen shows no evidence of renal calculi. The findings are those of osteitis fibrosa cystica which is probably dependent on a hyperparathyroidism. The patient should have blood calcium and phosphorus studies.

Blood calcium, 14.1 mg. per 100 c.c. Blood phosphorus, 2.9 mg. per 100 c.c. Other laboratory examinations not remarkable.

On October 19, an exploration of the neck for parathyroid tumor was carried out. A transverse incision was made across the base of the neck and the skin dissected back to give ample room for thyroid dissection. The facial layer was incised longitudinally and the right lobe of the thyroid exposed. The thyroid gland was then gradually dissected out from its base and the lower pole of the right lobe was turned up and a search for the parathyroid made. There came into view a small tumor about 1 cm. in diameter. This was entirely separate from the thyroid with a pedicle and a capsule of its own, and seemed to be unquestionably the pathological parathyroid. This was easily separated from its surrounding tissue, its pedicle clamped off and cut away.

Microscopic examination of the tissue removed showed an aberrant lobe of the thyroid

gland. There was no evidence of parathyroid tissue in the specimen. Following operation the patient showed slight symptomatic improvement and there was a temporary fall in the blood calcium.

She was again admitted to the hospital in April, 1932, symptomatically very much worse. Blood calcium was 21 mg. per 100 c.c., blood phosphorus 2.0 mg. per 100 c.c. A biopsy from the cystic area in the mandible was taken which showed the microscopic picture of benign giant cell tumor, thus confirming the diagnosis of osteitis fibrosa cystica beyond question. A second exploration of the neck was carried out in May, 1932, but no parathyroid tumor was found. Following the operation the blood calcium remained elevated to 14.4 mg. per 100 c.c. and the phosphorus was lowered, 3.1 mg. per 100 c.c.

The patient was not seen again until September, 1932. At this time she complained of severe pain in the left shoulder and in the left hip. She walked with extreme difficulty and stated that she spent most of her time sitting or lying down. High voltage roentgen treatment was instituted giving 700 r to the anterior neck, 600 r to the left shoulder and 600 r over the left hip. At the completion of the series there was no appreciable change in the patient's condition.

Case iv. (Huntington No. 32:291.) Female, aged, forty-four, single.

Patient first came under observation in March, 1932, with the complaint of pain in the right hip. This had been present for about five months and had become very severe at times. Patient walked with a considerable limp and used a cane. Her general health was otherwise excellent. She had a cholecystectomy fifteen years ago at which time gallstones were found. She had an anal fistula operated upon twice, once sixteen years ago and once a year ago. Her appetite has been good. The bowels have been regular and there have been no urinary symptoms. Menses have been regular. She has had no dyspnea or edema. When she was about nineteen years old she suffered from bronchitis and asthma, but this cleared up following injections which a doctor in New York gave her. The family history is negative.

Physical examination shows an obese woman of middle age. Head is normal. Eyes are negative. Fundi are normal with slightly more than average pigmentation. Mouth: Upper teeth false. Lower teeth are mostly false. Oral hygiene is good. Tonsils are enlarged and ragged in appearance. Pharynx is slightly red. One or two pea-sized lymph nodes are palpable in the right submaxillary region. Except for this the neck is negative. Deep palpation in the region of the thyroid reveals no evidence of tumor. Chest is normal externally. Breasts negative. Lungs are clear to percussion and auscultation. Heart borders cannot be made out because of obesity. Sounds are of fairly good quality and intensity. Rhythm is regular. No murmur is audible. Blood pressure 140/90. Abdomen is negative except for a right rectus incision scar through which the gallbladder was removed. Rectal examination shows scars of operations for fistula which are well healed. There is a slight, red, raised area at the right side of the rectum which may be the beginning of another fistula. Internally there is nothing abnormal felt. Extremities and reflexes are normal.

Urine examination: Sp. Gr. 1.022; acid; sugar, negative; albumin, trace; many white blood cells; few red blood cells; no casts.

Roentgen examination of the pelvis shows an extensive area of bone destruction involving the greater portion of the right ilium. The cortex of the bone is intact and there is no expansion of the bone. The area of destruction shows slight mottling and trabeculation. Flat film of the abdomen shows a right renal calculus, which finding is corroborated by ureteral catheterization. Film of the chest is negative. Films of the entire skeleton show no other abnormalities. There is no decalcification of the bones except the area described in the ilium.

Because of the presence of a renal calculus the possibility of cystic disease in the ilium was considered and blood calcium and phosphorus determinations were carried out by Dr. Joseph C. Aub. The blood serum calcium was found elevated to 13.5 mg. and the blood phosphorus was lowered to 1.7 mg. per 100 c.c.

The patient was given high voltage roentgen therapy to the right hip in the hope of relieving the pain. A total of 600 r was given posteriorly and 400 r anteriorly. About a month following the treatments the pain disappeared entirely and it has not returned. She walks perfectly normally without the use of a cane. The irradiation was sufficient to produce cessation of menstruation. Temporarily following irradiation the blood calcium returned to normal, but since has again become elevated. The question of exploration for a parathyroid tumor is being con-

sidered, although there is no mass palpable in the neck.

Case v. (Huntington No. 32:599.) Male, aged fifteen; first seen by us in May, 1932.

At the age of three years the patient had a severe attack of whooping cough and the mother states that the boy has never been well since. The present illness apparently started three years ago with a severe attack of erysipelas. At this time pain in the ankles and various parts of the body developed. The patient vomited a great deal following the erysipelas and there has been more or less nausea and vomiting since. The patient seems to suffer from general weakness and there is no spring to his muscles. When he walks upstairs he pulls himself up by his hands. About a year ago he began to drink large amounts of water and at this time a rather pronounced polyuria began. The appetite is poor. The bowels are fairly regular. Patient becomes easily fatigued and is short of breath. He has had no edema of the ankles. No cough. There has been no loss of weight recently, but during the past three years there has been practically no gain in weight. Two months ago the patient's mother noticed that the right side of his face was swollen. The patient was taken to the Deaconess Hospital where one of the upper right teeth was removed and a growth on the upper jaw curetted. This returned and was again removed after about two weeks. The right antrum was also cleaned out at this time. The diagnosis was epulis. The patient has attained the second year in high school in spite of much illness. The past history and family history are not remarkable.

Physical examination. The most striking thing about this patient is the disproportion of length of body and legs. The lower extremities are extremely long when compared with the trunk. He is quite thin and emaciated. The muscular development is poor. In spite of this his posture is not so bad as might be expected. The eyes are normal externally. Pupils are equal and react to light. Oral hygiene is good. Tonsils are not enlarged. There is a slight mucopurulent post-nasal drip. There are no lymph nodes enlarged in the neck, axillae, or groins. There is a mass $4 \times 4 \times 2$ cm. at the left of the thyroid cartilage and upper part of the trachea. This mass is quite easily visible as well as palpable. The external aspect of the chest shows moderate beading of the costochondral junctions. All of the attachments of the diaphragm to the ribs can easily be detected by slight deformity. The relative cardiac dullness is not increased. The cardiac apex is palpable 6 cm. to the left of the midline in the 5th interspace 2 cm. within the mid-clavicular line. Sounds are of fair quality and intensity. The first sound at the apex is slightly roughened. The pulmonic and aortic second sounds are equal. There is a slight sinus arrhythmia present. Blood pressure 135/80. The lungs are clear to percussion and auscultation. The liver and spleen are not palpable. There are no abdominal masses felt. There is no tenderness over the long bones, but there is slight tenderness over the spine. The only deformity present is that of the ribs. The reflexes are normal.

Roentgen examination. The first roentgen studies were carried out by Dr. Merrill C. Sosman at the Peter Bent Brigham Hospital. The report is as follows: Examination of the skull presents a uniform, coarse mottling of all the bones, apparently with marked decalcification. There are several small, clear areas in the bone suggesting small cysts. There are no other localized changes and no signs of pressure. The clinoids are atrophic, but the pituitary fossa is otherwise normal. There is an irregular cystic area around the left lower second bicuspid. There is definite clouding of the right antrum. Films of the chest show abnormal bone, deficient in calcium with indefinite changes in the epiphyses but no definite cysts. The lungs are essentially normal. The findings strongly suggest the osteoporosis associated with a hyperparathyroidism. This could be confirmed by finding a high blood calcium. Further examination, including films of the spine and pelvis and all the long bones, presents a remarkable picture of a diffuse uniform osteoporosis, finely mottled in appearance so that the bones look like a sieve. This is uniform throughout the bone with the exception of the ends of the diaphyses where there is condensation of the bone and loss of structure. In the vertebrae there is condensation just under the vertebral plate so that the bodies present a rather hollow appearance. Many of the bones show areas of erosion just proximal to the condensed areas at the epiphyseal lines with new bone formation suggesting periostitis. This is particularly well shown in the upper ends of the humeri. Some of the epiphyses are abnormal, particularly those in the lower ends of the radii. There are no definite cysts seen. There are no renal calculi visible.

The findings are most probably due to the osteoporosis of hyperparathyroidism.

The patient was referred to Dr. Joseph C. Aub at the Huntington Hospital for calcium studies. The blood calcium and phosphorus determinations were as follows: Calcium 19.4 mg. per 100 c.c. Phosphorus 4.0 mg. per 100 c.c. Other laboratory studies as follows: Urine—clear; Sp. Gr. 1.005; neutral litmus reaction; no sugar; trace of albumin; moderate number of pus cells; a few granular casts. Blood: red blood cells, 3,610,000; white blood cells, 11,600; Hb. 65 per cent. Differential: polymorphonuclears, 59 per cent; polymorphonuclears, young, 5 per cent; eosinophils, 2 per cent; small lymphocytes, 23 per cent; large lymphocytes, 7 per cent; atypical lymphocytes, 1 per cent; mononuclears, 2 per cent; myelocytic neutrophils, 1 per cent. Phenolphthalein renal test, total output 35 per cent.

Films of the entire skeleton made by us confirmed in all respects the findings reported by Dr. Sosman.

Following these studies the patient was again referred to the Peter Bent Brigham Hospital and on June 4, 1932, an adenoma of the left parathyroid was removed. Following the operation the blood calcium fell to 9.0 mg. per 100 c.c., and the phosphorus determination was 2.6 mg. per 100 c.c.

On July 18 the patient returned for observation. He has gained 5 pounds since he left the hospital and feels much better. He is able to walk and exercise as he never did before. He is able to jump on his toes and walk on his heels without any pain.

On September 8, the patient returned for further metabolic study. There has been a surprising improvement since his discharge. He has gained over 20 lb. in weight. The polyuria has ceased. There is no longer any pain or discomfort on walking. The operative scar in the neck is well healed. The physical examination is entirely negative.

Material for this publication has been collected from the Massachusetts General Hospital, the Worcester Memorial Hospital, and the Huntington Memorial Hospital.

REFERENCES

1. Albright, F., Bauer, W., Claflin, D., and Cockrill, J. R. Studies in parathyroid physiolgy; effect of phosphate ingestion in clinical hyperparathyroidism. *J. Clin. Investigation*, 1932, *11*, 411–435.
2. Dresser, R., and Hampton, A. O. Osteitis fibrosa cystica generalisata with hyperparathyroidism as etiology. Am. J. Roentgenol. & Rad. Therapy, 1931, *25*, 739–748.
3. Hunter, D., and Turnbull, H. M. Hyperparathyroidism; generalized osteitis fibrosa, with observations upon the bones, parathyroid tumours, and normal parathyroid glands. *Brit. J. Surg.*, 1931, *19*, 203–284.
4. Jores, A. Beitrag zur Differentialdiagnose des multiplen Myeloms und der Ostitis fibrosa generalisata mit besonderer Berücksichtigung des Kalkstoffwechsels. *Klin. Wchnschr.*, 1931, *10*, 2352-54.

DISCUSSION

Dr. P. F. Morse, Detroit, Mich. There are several points in Dr. Dresser's systematic dissertation that I think might well be emphasized and repeated because they seem to be of such clinical importance. He spoke of the localized and generalized cysts, and said that he did not think there should be too sharp a line drawn between those two conditions. That is a very important statement. We have run across it many times, especially in industrial accident cases. A patient will come in with a fracture of a bone in the foot or the hand. The roentgenologist will find that it is a pathological fracture that has passed through a single cyst and, without further investigation, will assume that it is merely an accidental cyst and that it has no general constitutional importance. Very often further examination of that patient will prove that it is really a case of parathyroidism, and the industrial accident will not improve until the general condition of parathyroidism is taken care of.

I was very much interested in his remarks about multiple myeloma of the bone, especially since we have come to our own conclusion that multiple myeloma of the bone merely represents a malignant end stage of osteitis fibrosa cystica. In the diffused general types of osteitis fibrosa cystica we have found that we can practically never make a positive diagnosis without biopsy. You can do all the things that you usually do, and still you are in doubt until you have a biopsy. The biopsy will often reveal the multiple myeloma when you cannot positively state it to be such upon purely roentgenological or other grounds.

Our cases have been rather uniform in showing a high blood calcium and low blood phosphorus, and most of all a lengthened chronaxie. Those are the three things that we regard as most important characteristics of parathyroidism, of course, outside of the roentgen findings. so that Dr. Dresser's remarks bring special emphasis upon an implied close relation between osteitis fibrosa cystica and multiple myeloma, at least those of the so-called plasma-cell type.

I was very much interested in his remarks regarding Albright's work of a high phosphate diet in some of these conditions. We have had no experience with the high phosphate feeding in any of our cases, but we feel very definitely that the finding of a parathyroid neoplasm is distinctly not necessary. We went through that in goiter work, we went through it in endocrine surgery in general, and the same thing applies to parathyroid work. You can have hyperactivity without obvious macroscopical or microscopical changes which can be definitely interpreted as a variation from normal, but those changes are sometimes remarkably small and often debatable, but the proof is in the clinical result. When these patients have not left their beds for two or three or four months, or have not been able to walk for a long time, and when they have been entirely incapacitated, and then after the removal of what might reasonably have been called grossly and also microscopically a couple of normal parathyroid bodies, they return to their work, and throw away their crutches, you have to be guided by clinical experience. So I do not think we should stick too closely to the dictum that there must be a parathyroid tumor or an enlarged parathyroid. We apparently will have to accumulate a little more experience before we can be sure in this matter.

GIANT CELL BONE TUMOR*

By CARLETON B. PEIRCE, M.S., M.D.
Department of Roentgenology, University of Michigan
ANN ARBOR, MICHIGAN

THE characteristics by which giant cell bone tumor may be identified as a pathologic entity have been restricted little since Nélaton's thesis of 1860. There has been some tendency to separate those tumors occurring in the maxilla from those of the extremities as a group. The nomenclature has been modified by the general acknowledgment that "sarcoma" is a misnomer for this lesion. On the other hand, malignant change, or concurrent bone maligancy, has been observed. For that reason, and the tendency of the tissue to become less controlled in growth pattern after repeated disturbance, the term "benign," in our opinion, is also inappropriate as misleading.

Structurally, giant cell bone tumor appears as an isolated, circumscribed, expansile new growth in bone, near the end of the diaphyseal portion. The tumor is usually trabeculated. As much of the bony structure as contains sufficient calcium to be visible on the roentgenogram appears well organized, the areas between trabeculae representing the soft giant cell masses and their supporting fibroblastic and spindle cell stroma. The predominant histologic component is the bone tumor giant cell, of varying size, and containing multiple, centrally grouped nuclei. These giant cells possibly arise from the endothelium of the abundant capillary blood supply in the spindle cell stroma. They bear a close resemblance to the osteoclasts, and may be found in the lacunae of the osteoid and osseous tissue of the trabeculae. The disposition of these masses of giant cells between the trabeculae has been indicated above. In some, hemorrhagic cystic areas lined by these giant cells lie between trabeculae giving rise to the description as "bone aneurysm." The bone cortex about the tumor may become actually paper thin, giving rise to the "egg-shell crepitus" on palpation, or entirely lacking in calcium as visualized on the roentgenogram. There is rarely invasion of the surrounding soft tissue. This may occur after an injury sufficient to fracture the cortex, or rupture the periosteal capsule. In our series the growing cartilage disc of the epiphysis was not invaded if the neoplasm appeared during the growing period. But after completion of growth and ossification of the disc, the bone of the epiphyseal end of the shaft is readily involved.

We have previously discussed the several theories of origin of this tumor.[8] The preponderance of evidence favors a normal constituent of bone as a source for the predominant cell. The proliferation with resultant development of such a tumor is probably a response to local trauma. This may be in the nature of a hemorrhagic osteitis, a bizarre organization of pre-callus, or a reversion of the proliferating bone cells toward fetal connective tissue. There is a local withdrawal of calcium, and retardation of the normal osteoblastic reparative proliferation, but with some attempt to form capsular and trabecular bone about the growing giant cell masses.

In our series there seems to be some relation between size of giant cell, age of the process, and age of the patient. The younger the patient, and the shorter the interval since onset of known abnormality, the larger the giant cells. Also, the cell contour seems at times to suggest almost a syncytial character, as though the giant cell had grown by fusion, or mitosis without fission of cytoplasm.

The cystic areas are most logically considered as of hemorrhage into the tumor with subsequent liquefaction, rather than

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

an essential cystic change of the bone. The remainder of the shaft of the affected bone shows no fibrotic degeneration.

In further consideration of the source of the bone tumor giant cell and the method of production of the tumor mass, the cystic areas of osteitis fibrosa cystica resemble closely in architecture the cystic and aneurysmal areas found in giant cell bone tumor. In both lesions the balance between bone formation and bone destruction is disturbed. In osteitis fibrosa generalisata the reformation of bone after demineralization is largely on the foundation of what appears to be a degenerative fibrous matrix. But there is apparently constitutional involvement, a true malacia. Giant cell bone tumor, on the other hand, is a local process of focal demineralization, and when bone is reformed in such an area does not show a fibrous matrix.

Giant cell bone tumor does not show the constitutional signs and symptoms (notably hypotonia, hypercalcemia, hypercalcuria, and deformity) of osteitis fibrosa cystica. It further exhibits a tendency to become locally malignant upon repeated insult.

There have been reported recently 3 cases of giant cell tumor of bone with concurrent parathyroid adenoma. These however were not isolated lesions. Each of these 3 patients had either multiple cystic areas (Pfahler) or an osteitis fibrosa generalisata with one prominent tumorous area, and the serum calcium changes associated with parathyroidism (Wilder, Barr et al).

Roentgen therapy is almost specific in its ability to induce ossification of giant cell tumor. I have observed the areas of cystic degeneration and of malacic fracture in osteitis fibrosa cystica to repair readily under roentgen therapy with no treatment of a possible parathyroid abnormality. Pfahler's case with multiple cystic bone tumors improved under roentgen therapy and removal of a parathyroid adenoma. Wilder's patient demonstrated regression of a tumor of the maxilla after removal of a parathyroid adenoma. There has been no report on Barr's case since operation.

It is perhaps possible that the parathyroid gland is one of the sources of control—not directly upon calcium utilization in the body—but upon the "myeloplaxique" or osteoclastic components of bone. The secretion of a hyperplastic or adenomatous parathyroid may induce the extensive destruction of bone by excess stimulus of the "myeloplaques" with resultant hypercalcemia and hypercalcuria.

The constitutional reaction in parathyroidism is due possibly to the excess calcium mobilization which results from an overactivity of the osteolytic elements rather than the inability of the osteoblastic components to fix calcium.

It is also possible that the parathyroid acts as a check valve on the pituitary and other glandular elements in the control of skeletal growth. A slight imbalance between parathyroid and pituitary secretion might contribute to the giant cell tumor type of response to local bone injury. If this were the situation, the constitutional manifestations would probably be lacking because of the small discard of bone calcium from so localized a lesion. Further, the giant cell tumor under such circumstances would not respond adequately to roentgen therapy.

I was asked to include leontiasis ossium for this symposium. I have had no personal experience with this disturbance, and hence prefer to discuss it only by analogy. The local lesions of "leontiasis ossium" suggest somewhat the type of overgrowth seen in the mandible in the acromegalic, with a further proliferative osteitis. This may be, as suggested above in the case of giant cell bone tumor, a manifestation of imbalance of pituitary-thyroid-parathyroid ratio in a localized or minimal form, but in the reverse direction.

In conclusion, I do not feel that the evidence is sufficient at the present time to place giant cell tumor in the group of "primary parathyroid osteomalacias."

REFERENCES

1. Ballin, M., and Morse, P. F. Parathyroidism. *Am. J. Surg.*, 1931, *12*, 403–416.
2. Ballin, M., and Morse, P. F. Parathyroidism and parathyroidectomy. *Ann. Surg.*, 1931, *94*, 592–609.
3. Barr, D. P., Bulger, H. A., and Dixon, H. H. Hyperparathyroidism. *J. Am. M. Ass.*, 1929, *92*, 951–952.
4. Boyd, J. D., Milgram, J. E., and Stearns, G. Clinical hyperparathyroidism. *J. Am. M. Ass.*, 1929, *93*, 684–688.
5. Hunter, D. Hyperparathyroidism. (Hyperfunction of parathyroid tumour in case of generalized osteitis fibrosa.) *Proc. Roy. Soc. Med.* (*Sect. Med.*), 1929, *23*, 27–34.
6. Hunter, D. Goulstonian lectures entitled significance to clinical medicine of studies in calcium and phosphorus metabolism. *Lancet*, 1930, *1*, 897; 947; 999.
7. Klemperer, Paul. Parathyroid hyperplasia and bone destruction in generalized carcinomatosis. *Surg., Gynec. & Obst.*, 1923, *36*, 11.
8. Peirce, Carleton B. Giant-cell bone tumor. Am. J. Roentgenol. & Rad. Therapy, 1932, *28*, 167–188.
9. Snapper, I. Parathyroid tumor and changes of the bones. *Arch. Int. Med.*, 1930, *46*, 506–523.
10. Wilder, R. M. Hyperparathyroidism; tumor of the parathyroid glands associated with osteitis fibrosa. *Endocrinology*, 1929, *13*, 231–244.

DISCUSSION

Dr. Max Ballin, Detroit, Mich. Dr. Peirce is absolutely right that there are some giant cell tumors that do not belong to the parathyroid group. All we wanted to show up to now is that a good many of the giant cell tumors are of this origin. A monostotic cyst seems to be rare; if patients with seemingly solitary cysts are studied for calcium and phosphorus chemistry and a general survey of the skeleton is made one will be surprised how many of them show more symptoms of parathyroidism as foci of osteitis fibrosa cystica, hypercalcemia, and so on. At autopsy cases with monostotic processes have gross and microscopical changes all over the skeleton (Ask-Upmark and others).

The important pathological suggestion to be considered is that there seems to be a whole class of tumors of neoplastic formations that have intimate connection with endocrine, parathyroidal pathology and can frequently be arrested by removal of adenomatous or hyperplastic parathyroids.

Three amputations of limbs for such giant cell tumors have been described in the literature: for instance, in Beck's case a leg was amputated three years before a parathyroid tumor was found, no doubt the cause of the giant cell tumor described, for which the amputation was done. We have already mentioned the pitiful case of an English surgeon who amputated one leg on account of a decalcified mass around a femoral fracture being considered malignant and recognized the parathyroid origin of this affection only when the same process arose in the remaining leg. Here it was cured by removal of a parathyroid tumor. If a few such cases are recorded by courageous men many more have occurred without being given publicity.

Likewise the giant cell tumors of the jaw have an etiological connection with parathyroidism. Barr and Bulger have published such a case, a slide of which is shown here, with giant cell tumors proved by biopsy permeating the mandible, that did not get better from curetting and so forth, but disappeared after parathyroidectomy.

Here is another slide showing practically total disappearance of the jaw. The total decalcification came on gradually without any special reason. This film was sent to us for an opinion as to the possible parathyroidal origin of the affection; it certainly resembles the femur and the pelvic slides where all contour has disappeared, in the case of parathyroid adenoma (Hunter, Ballin, Morse, et al.)

Again a slide of a woman who, fifteen years ago, went to Holland on account of a tumor of the maxilla; the jaw was resected for the diagnosis of sarcoma. She came back to us after a year with the loss of half of her maxilla but the process had extended to the other side of the maxilla. That was at least fourteen years ago and she is still robust in spite of this "sarcoma." Later on a general roentgen check-up showed osteitis fibrosa cystica of the skull and pelvis. Furthermore, her brother and one sister have the same roentgenological changes through their skeletons. Hereditary factors are mentioned several times in parathyroid literature.

A few more slides show how giant cell sarcomas disappear immediately after parathyroidec-

tomy (Hunter, Ballin, Morse, Léri, and others).

In conclusion it seems to be our duty in all giant cell tumors of the skeleton, also of the jaws, to exclude the possibility of parathyroid origin to avoid unnecessary operations on bones and curetting, not to speak again about resection and amputations, if the removal of a parathyroid tumor can establish cures as has now been shown so often.

Dr. P. F. Morse, Detroit, Mich. The question of a monostotic and polyostotic process is always an embarrassing one. We never know when to say a monostotic osteitis fibrosa is going to become a generalized type, and I think that we are going to have this same question regarding the giant cell tumor. There doesn't seem to be very much opposition to admitting the multiple giant cell tumors into the parathyroid group, but there is quite a prejudice against admitting the single giant cell tumors. We have had one recent experience which was very instructive, although we do not yet know how it is going to come out.

In 1925 Dr. Ballin did a biopsy on a single giant cell tumor in a man at about the age of thirty. We have the section. It is an ordinary, garden variety of giant cell tumor. In 1928 the tumor recurred, and we did another biopsy. It is still the ordinary, garden variety of giant cell tumor. There are no other lesions in the body. This year the tumor recurred again. It is a beautiful example of Dr. Dresser's statement that they often become malignant after repeated traumatization, because this time it presents the picture of a polymorphous cell sarcoma of very malignant type and we have grave doubts as to its prognosis. That man was parathyroidectomized, and he had about the most pathological parathyroid adenoma I have seen in months. I cannot tell you how that case is coming out. He may die of malignant sarcoma, but I can't get away from a feeling that the association of that monostatic giant cell tumor, recurring twice, and finally becoming malignant, with a very pathological parathyroid gland was not a coincidence.

ANKYLOSING SPONDYLITIS AND POLYARTHRITIS*

(BECHTEREW, STRÜMPELL-MARIE, AND RELATED TYPES)

By E. WALTER HALL, M.D.
DETROIT, MICHIGAN

IN THE earlier part of the past century cases of ankylosing spondylarthritis were classified as arthritis deformans, a term suggested by Virchow. In 1893 von Bechterew, from observation of 500 cases of spinal rigidity, found some which seemed to him to present distinct characteristics and to be worthy of classification as a separate disease. He recognized a type of spinal arthritis in which there was progressive stiffening of the vertebral column beginning in the thoracic region and extending downward, associated with marked thoracic kyphosis. This was accompanied by signs and symptoms of nerve involvement, namely, paralysis and atrophy of the muscles of the back, especially the upper portions, diminished sensitivity of cutaneous nerves, changes in reflexes, and psychic phenomena. Other joints of the body were thought by Bechterew to be uninvolved.

Bechterew's spondylitis is so well known to roentgenologists that only a brief description is necessary. In advanced cases there are shown roentgenologically a well-rounded dorsal kyphosis with anterior narrowing of the vertebral bodies which are fused at their anterior margins, marked atrophy of the intervertebral discs with much deposit of calcium in the cartilages, and ossification of the paraspinal ligaments. Due to the muscular atrophy which is present and believed by some to be primary to the changes in the vertebrae, Knaggs has called this type "spondylitis muscularis." Bechterew regarded trauma as the exciting cause of the disease with an underlying hereditary predisposition as the main etiologic factor. He considered trauma as ineffective in producing the disease without the presence of such a hereditary tendency. Marie recognizes these etiologic factors in his term for the condition, "cyphose hérédo-traumatique."

Strümpell in 1897 and Marie in 1898 described a somewhat different form of ankylosing spondylitis in which the disease is first manifested in the lower spine and progresses dorsalward. In this type of malady there is usually prostration, the patient being confined to bed, and generally in severe pain. Stiffness progresses rapidly and pathologic changes, though starting in the lower back, soon involve all the portions of the spine rather uniformly.

Strümpell-Marie's spine is also well known to all roentgenologists so it is necessary to review only the main roentgen findings. In marked cases, we find the sacroiliac joints entirely obliterated by a firm, bony ankylosis. The vertebrae show no change in form, although there is generalized demineralization. The intervertebral discs are of normal width but take on an osseous character and the paraspinal ligaments are ossified, forming a thin bony sheath for the entire column. The usual involvement of the hips and shoulders in the ankylosing process led Marie to designate the affection as "spondylose rhizomelique." Marie believed the disease he described to be limited to the joints of the spine and the roots of the limbs, the other joints of the body being uninvolved in the process. Knaggs classifies the Strümpell-Marie type of spondylitis as "spondylitis ossificans ligamentosa," considering the ligamentous ossification to be the most important change in the involved tissues. Marie considered this form of ankylosing spondylitis not directly infectious but probably of toxic origin and indicated the possibility of a nutritional basis for the disease. He admitted that Neisserian infection gave a picture at times

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

indistinguishable except for the history.

Many writers question the validity of separating the Bechterew and Strümpell-Marie types of spondylitis from other forms of generalized arthritis which may or may not affect the spine. Tubby believes that arthritis deformans accounts for the greater portion of rigid spines and probably all of those of the Bechterew type. Heinemann-Grüder presents a number of cases showing characteristics of both chief types of ankylosing spondylitis as well as of arthritis of the smaller joints of the extremities and believes they are not distinguishable symptomatically, pathologically, or from the standpoint of etiology. Oppel believes that spinal manifestations are mere incidents and that in a given disease manifested by arthritic changes the same physical and chemical factors are operative in the selection of the spine as the site of the involvement as of other parts of the body. Of these factors trauma, occupational posture, strain, or pre-existing local infection may play a part. Steindler holds the view that to regard spondylarthritis as a systemic disease with spinal manifestations merely as the cardinal symptoms gives the best approach to relief of symptoms and arrest of the process. It is this point of view that we wish to emphasize and which we believe may give new impetus to the treatment of ankylosing spondylarthritis after several decades of relatively little progress.

As stated above, the chief etiologic factors in the so-called Bechterew or hypertrophic type of spondylarthritis are supposed to be hereditary predisposition and trauma, and in the so-called Marie or atrophic type some toxic condition associated with chronic infection, with the possible added influence of trauma. To quote Heinemann-Grüder, "Neither trauma nor infection but a latent readiness of the body to answer to irritation of many kinds by producing spinal ankylosis is the fundamental consideration in this problem."

The question is naturally suggested as to whether the type of cases under discussion can be logically considered to be of metabolic or endocrine origin, and so related to parathyroid function that a therapeutic approach can be made from this angle. It is quite evident from a study either of roentgenograms or of necropsy specimens that in ankylosing spondylitis we are dealing with a condition of calcium metastasis. Much calcium is absent from its normal place in the bones and is present in large amounts in the soft tissues surrounding them. That it is distributed in different locations and degree seems not to be vital to the question, but rather significant of the presence and influence of various mechanical factors.

FIG. 1. Bechterew's spondylitis. Calcium deposits in the ligaments and in the intervertebral discs in the mid-thoracic region. Slight wedging of the vertebral bodies which are demineralized except the margins adjacent to the cartilages.

FIG. 2. Bechterew type. Calcium metastasis to the ligaments, the discs being preserved and the vertebral bodies not deformed. Such a case responds favorably to alterations in calcium and phosphorus metabolism through the parathyroids.

In the slowly progressive Bechterew type of spondylopathy the factors are operative over long periods of time. Due to the fact that the patient is not incapacitated, stress, strain and mobility are continually active and influence the architecture as well as the chemical composition of the bones. The hypotonicity of the muscles of the back, which is one of the known manifestations of hyperactivity of the parathyroid glands, allows the spine to be bowed forward and at the same time lessens the mobility. Pressure is brought to bear on the intervertebral discs anteriorly, producing atrophy of cartilage to the extent that the bodies eventually contact and fuse with osteophyte formation. Whether it is a protective measure or not it is difficult to say, but for some cause, calcium salts are removed from the vertebrae and deposited in adjacent spinal ligaments, causing further ankylosis. This is, no doubt, partially due to lessened ligamentous function. Eventually the functionless cartilages also become the depository for mineral salts. Ossification of the less expansile discs advances from the periphery to the center, as

FIG. 3. Strümpell-Marie type of spondylitis. Calcified ligaments, normal size of intervertebral discs and normal body contour.

would be expected both from the greater insult to the periphery anteriorly and from the greater lability of the nucleus pulposus. The vertebral bodies seem to show greater lime content anteriorly where there is osteophyte formation, but careful observation shows them considerably decreased in density elsewhere so that their total mineral salt content is definitely lessened. In this condition, therefore, we find two probable effects of parathyroidism: the first in producing hypotonicity of the musculature, and the second in regulating calcium metastasis. In this connection it may be stated that most authors consider the dorsum rotundum of adolescence and that of senility to belong in the same group as the Bechterew type of spondylitis.

The Strümpell-Marie type, as Knaggs' term "spondylitis ossificans ligamentosa" indicates, has for its chief feature marked transposition of mineral salts from the vertebral bodies to the adjacent ligaments. This occurs so rapidly that mobility of the spine is greatly reduced early in the disease, consequently no deformity of the bodies occurs, neither is there pressure atrophy of the intervertebral cartilages and the disc spacing remains normal throughout. The anterior longitudinal ligament is first to ossify, this occurring very early in the illness. Later the posterior common ligament, and ligamenta flava, the capsular ligaments of the articular processes, and finally the costovertebral ligaments become firmly ossified. At this stage the intervertebral discs, no longer functional, undergo calcification and ossification, the process progressing from periphery to center.

Here, then, is a most spectacular disturbance in calcium distribution. Most authorities have assumed that the calcium metastasis is purely a defense reaction, that it is Nature's method of immobilization of painful joints in preserving them from destruction. This explanation seems inadequate in view of the relatively small effort Nature makes to immobilize the joints in many other localized destructive and painful arthritides. A more plausible view is that the calcium metabolism is not under normal control, or is unduly stimulated so that if Nature is trying to protect the diseased areas she carries the process entirely too far. If, as seems proved in many cases, infection plays a major part in the etiology of spondylitis, it seems quite prob-

Fig. 4. Spondylitis, chiefly atrophic. This patient showed a general polyarthritis of ankylosing type following scarlet fever. The absence of definite calcium metastasis would render this type somewhat unfavorable to therapeutic alteration of parathyroid function.

able that the toxins from the same infectious process act as parathyroid stimulants so that parathyroidism becomes the most important, if not the primary, factor in producing the para-articular changes. It is also an interesting speculation as to whether there may not be a hereditary or familial tendency to parathyroid dysfunction to explain the quite generally accepted hereditary factor in spinal ankylosis of the Bechterew type. This is a problem worthy of careful study.

Oppel and his associates have conducted investigations into the metabolism of patients suffering from spinal as well as generalized ankylosing arthritis. He reports that Belsgorodsky found all patients of his series with ankylosing polyarthritis to have increased blood calcium, while Samarin found serum calcium increased in only 28 of a series of 42 such cases, the remaining 14 being normal.

Barr believes that calcium metastasis is dependent not on hypercalcemia but rather on hyperphosphatemia, there being extensive deposit of calcium salts in soft tissues when the serum phosphate is elevated with only slight increase in serum calcium. Conversely, cases with marked hypercalcemia and low serum phosphate may show extensive demineralization of bone with no demonstrable deposit of calcium in the soft tissues. Nekrosoff found the inorganic phosphorus increased to 3.43 mg. per 100 c.c. (the normal being 2.8 mg.), while the organic phosphorus was normal. Demidovskaya found the viscosity of the blood increased from 20 to 40 per cent. Samarin found lymphocytes increased to 50 per cent of the total white count in the blood of 75 per cent of the series. Simon, Levy, Weissenbach, Le Riche and others, report blood calcium determinations quite variable, the calcium being often not only unincreased but even decreased.

However varied the laboratory findings, the patients have benefited by changing the calcium metabolism. Some have responded to surgery while others with almost identical symptoms have improved following injections of parathormone. Simon believes hypofunction of the thyroid may play an important part in the production of ankylosing arthritis while some investigators give more credit to the pituitary gland. The whole question is yet in a state of uncertainty and shares in the complexity of endocrine problems in general.

Oppel's laboratory and clinical findings are sufficiently indicative of parathyroid dysfunction to have induced him to remove the parathyroid in many cases of ankylosing polyarthritis. His results have been highly encouraging. Of a series of 30 cases 27 showed 1 to 3 mg. reduction in serum calcium after parathyroidectomy. The symptomatic results were even more striking, the sensation of stiffness and pain being entirely relieved in one patient after twenty-six hours and in others almost as soon. Joints in which motion was almost impossible became freely movable. Patients with stiffened spinal columns increased in stature several centimeters due to their ability to assume a more erect position.

Other surgeons have had results similar to those of Oppel. Ballin and Morse have reported several cases seemingly belonging to the Bechterew type of spondylitis in which parathyroidectomy produced marked relief of pain and stiffness. Simon has reported a number of cases of ankylosing polyarthritis with favorable results from operations in the region of the parathyroids with or without removal of parathyroid tissue and with no demonstrable microscopic change in tissues which were removed. Whether or not the parathyroid, the thyroid, or the pituitary theory is accepted as the correct explanation for the conditions under discussion, the remarkable clinical effects of surgical procedure in the region of the lower pole of the thyroid are indisputable. Of course one cannot hope to restore articulations to normal where there is complete ankylosis with formation of solid bone, but symptoms are definitely relieved and in early or moderately advanced cases there is every reason to expect the arrest of the ankylosing process by

parathyroidectomy. Oppel's successes have led him to advocate removal of parathyroids previous to every arthroplasty for cure of ankylosis, logically assuming that recurrence of ankylosis is less likely when calcium metastasis is prevented.

It should be borne in mind that while no assertion is made that parathyroidism is the chief or primary cause of the usual forms of polyarthritis, the generally accepted theories of infection and toxic conditions being the most plausible explanation on clinical grounds, parathyroidism is probably responsible for the ankylosing feature seen in so many cases. The theory that endocrine imbalance with resultant calcium metastasis is the main etiologic factor in certain types of ankylosing spondylarthritis of obscure etiology is quite tenable and worthy of use as a working basis for clinical purposes.

It is to be hoped that results of reported cases will stimulate those in charge of patients with ankylosing arthritis, and especially the early cases with muscular hypotonia, stiffness, and pain preceding the stage of joint ankylosis, to investigate them very thoroughly with the idea of parathyroidism in mind. We believe that in many instances parathyroidectomy would benefit the chronic arthritic showing tendencies toward ankylosis more than many of the routine measures now employed in their treatment. We would not minimize the importance of removal of foci of infection and general therapeutic procedures, but rather emphasize this new instrument which may be effectually used to prevent ankylosis.

REFERENCES

1. Ballin, M., and Morse, P. F. Parathyroidism. *Am. J. Surg.*, 1931, *12*, 403–416.
2. Ballin, M., and Morse, P. F. Parathyroidism and parathyroidectomy. *Ann. Surg.*, 1931, *94*, 592–609.
3. Barr, D. P. Pathological calcification. *Physiol. Rev.*, 1932, *12*, 593–624.
4. Von Bechterew, W. Stiefigkeit der Wirbelsäule und ihre Verkrummung als besondere Erkronkungsform. *Neurolog. Centralbl.*, 1893, *13*, 425–434.
5. Geist, Emil S. The intervertebral disk. *J. Am. M. Ass.*, 1931, *96*, 1676–1679.
6. Heinemann-Grüder. Betrachtungen zur Frage der ankylosierenden Spondylitis. *Arch. f. klin. Chir.*, 1927, *145*, 527–560.
7. Hunter, D., and Turnbull, H. M. Hyperparathyroidism. *Brit. J. Surg.*, 1931, *19*, 203–284.
8. Knaggs, R. L. Spondylitis deformans. *Brit. J. Surg.*, 1925, *12*, 524–546.
9. Levy, M. Un cas de rhumatisme chronique déformant traité avec succès par la parathormone. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1931, *55*, 1847–1849.
10. Marie, Pierre. Sur la spondylose rhizomelique. *Rev. de méd.*, 1898, *18*, 285–345.
11. Oppel, V. A. Parathyroidectomy for ankylosing polyarthritis. *Ann. Surg.*, 1929, *90*, 978–981.
12. Richardson, E. P., Aub., J. C., and Bauer, W. Parathyroidectomy in osteomalacia. *Ann. Surg.*, 1929, *90*, 730–741.
13. Schmorl, C. G. Pathologic anatomy of the intervertebral disc. *Beitr. z. klin. Chir.*, 1931, *151*, 360–375.
14. Simon, R. Des opérations thyroïdennes et parathyroïdennes dans le rhumatisme chronique déformant. *Rev. franç. d'endocrinol.*, 1932, *10*, 36–60.
15. Simon, R., and Weill, J. Operations sur la région des parathyroïdes et rhumatisme déformant. *Presse méd.*, 1932, *40*, 412–414.
16. Snapper, I. Maladies osseuses et parathyroïdes. *Ann. de méd.*, 1931, *29*, 201–221.
17. Steindler, Arthur. Diseases and Deformities of the Spine and Thorax. C. V. Mosby Co., St. Louis, 1929, pp. 498–525.
18. Tubby, A. H. Deformities, Including Diseases of the Bones and Joints. 1923, Vol. II, 425.
19. Weissenbach, R. J., Françon, F., Perlès, L., and Seidmann, P. Traitement de certaines formes graves du rhumatisme chronique déformant progressif par les extraits parathyroïdiens. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1930, *54*, 1843–1854.

DISCUSSION

DR. P. F. MORSE, Detroit, Mich. Dr. Evans has suggested that it might be well to get a little better fixed in your minds this question of ankylosing spondylitis and polyarthritis. Dr. Hall went over the details and emphasized the proper points, but we still often find that the medical profession misinterprets Oppel's point of view. In the first place, Oppel does not claim that the parathyroid has anything to do with the rheumatism. He does not claim that it has anything to do with the spondylitis, whether it be of the Strümpell-Marie or Bechterew type.

All that Oppel claims is well illustrated by one of his experiments in which he took a normal dog and put a ligature above and below the joint to produce chronic hyperemia in a normal dog and then administered parathormone over a long period of time. They were able to ankylose that normal joint.

Oppel did claim that when any polyarticular rheumatism on an infectious or other basis is accompanied by a coincident parathyroidism and hypercalcemia, progressive ankylosis and joint pain result. Those of you who have read Oppel's papers will appreciate the remarkable results he has obtained. Besides this phase we should keep in mind the purely rheumatic symptoms of parathyroidism itself.

Some of the clinical details of Dr. Ballin's cases are very striking. I wish he would say a few words about one of his recent cases which has not yet been operated upon.

DR. MAX BALLIN, Detroit, Mich. Oppel reports his cases very carefully and claims only about 50 per cent good results from parathyroidectomy in "ankylosing polyarthritis." We have done 15 such operations for the arthritic type; we had good or fair results in only about 10 cases. That, perhaps, indicates the most important point, that one should pick out such cases very carefully. Our orthopedic friends and, in fact, every physician and patient with arthritis, are apt to try almost anything in this stubborn affection, but we must be very careful not to spoil this chapter of parathyroidism by indiscriminately applying parathyroidectomy for arthritis.

Generally arthritis has nothing to do with parathyroidism, but at times parathyroidism goes under outstanding symptoms of arthritis and then we have to substantiate the diagnosis by bringing out other parathyroid symptoms. I do not believe that the difference in types of arthritis, be it the Strümpell-Marie or Bechterew type, should be the distinctive feature. To call an arthritis parathyroidal we should have, besides arthritis, hypotonia of the muscles, some changes in the blood chemistry and phosphorus chemistry, even if not very pronounced, also a roentgenogram showing decalcification, areas of osteitis fibrosa cystica and secondary calcium deposits.

Oppel and his pupils have made experiments by injecting dyes into the blood stream and these were deposited around inflamed joints exactly in the spots where the metastatic calcium deposit takes place and where there was inflammation previously. He further states that an infectious arthritis generally heals without ankylosis. The latter occurs in only 5 to 10 per cent; and then hypercalcemia and secondary calcium deposits enter the picture to produce ankylosis. Ergo, more symptoms of parathyroidism are needed to include an arthritic process in this group.

Osteopoikilosis can perhaps be understood also as such metastatic calcium processes. I think Dr. Wilcox said osteopoikilosis had been reported about 15 times. Since then at Harper Hospital several such cases and in our own service 5 or 6 cases have been seen. It is therefore not so infrequent, but as it usually produces no symptoms it is not looked for generally. However, more and more, here and there we are seeing it in combination with parathyroid osseous changes and one French case has been reported where an actual parathyroid tumor was found.

And here is a film of a real parathyroid tumor case of ours with giant cell sarcoma, etc. You can see the calcium coming back in spots after parathyroidectomy. We have seen that now in 3 cases. In other words, in parathyroidism the calcium comes back intensively in spots resembling osteopoikilosis; but I do not say at this time there is any etiological relationship between parathyroidism and osteopoikilosis.

OSTEOPOIKILOSIS*

By LESLIE F. WILCOX, M.D.
Assistant Roentgenologist, Harper Hospital
DETROIT, MICHIGAN

OSTEOPOIKILOSIS is characterized by a disseminated condensation of the bones of the skeleton without clinical symptoms. All of the bones have been shown to be involved except the bones of the skull. The multiple areas of increased density vary in size from foci 2 millimeters in diameter to those having a width of several millimeters and a length of several centimeters. Thus they may be grossly spherical, oval or oblong in form. Curiously enough, they are always found in the spongiosa of the epiphysis and the metaphysis of the bones. They are not found in the mid-portion of the diaphysis of the long bones. These foci of condensation in the cancellous bone are arranged so their long axis is parallel to the long axis of the shaft, except in such parts as the neck of the femur where they do not lie strictly axially but follow the shaft structure of the column very distinctly.

The condition has been observed in both males and females and as it occurs without symptoms, it is found by accident during a roentgen examination for some other condition. The blood calcium and phosphorus determinations have been normal in those cases in which it was studied.

Albers-Schönberg[1] first reported a case in 1915 calling it a rare structural anomaly of the skeleton. Ledoux-Lebard, Chabaneix and Dessane[8] reported a case the next year and because of the spotted appearance of the bones they gave it the name "osteopoecilia." In 1929 Newcomet[11] of Philadelphia reported the first case in the English literature. His case had been observed over a period of four years and during that time there had been no change in the character of the bone involvement.

Three types of this condition have been described by several authors. These are, the spotted form which is the one most commonly seen, the striated form which is relatively rare and in which there are long narrow striations of dense bone and the mixed form which is a combination of the two.

In a search of the literature we have been able to find 23 cases of osteopoikilosis which include 2 cases recently reported by me[22] and of which a brief résumé is given here.

Case I. H. C., white male, aged twenty-one, bookkeeper, was admitted to the Surgical Service of Harper Hospital, October 22, 1931, with a history of lower abdominal pain. During a previous roentgen examination elsewhere of the urinary tract, an unusual condition of the bones of the pelvis was observed and he was sent to the roentgen department for further study. The past history of this patient was entirely negative.

Laboratory examination in the Hospital revealed nothing of importance. There was no anemia or leucocytosis and the urinary findings were negative. The blood calcium was 10.5 mg. and the inorganic phosphates 2.5 mg.

Roentgen Report. Examination of the patient's skull, dorsal and lumbar spine, pelvis and the extremities, including the hands and feet, reveal a rather unusual distribution of calcium deposit or increased bone density in the ends of the bones, especially in the humeral heads, the glenoid process of the scapulae, head, neck and intertrochanteric regions of the femora, in the ilia, both ischial and pubic bones, sacrum and spinous processes of the lumbar vertebrae, the lower ends of the tibiae, the bones of the feet, the lower ends of the radii and the ulnae, all of the bones of the wrists and most of the phalanges, to a greater or less extent. The bones of the skull, the ribs and the mid-portions of the shafts of the long bones were alone uninvolved.

Case II. M. C., white male, aged fifty-two, the father of Case I, was examined. The past history in this case was also essentially negative.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

Roentgen Report. Examination was made of the pelvis, both hands, right knee and right foot. Multiple small areas of increased density were present in the bones of the wrists and hands, the ilia, sacrum, ischii and pubic bones, the femur, tibia, fibula and all the bones of the foot.

A brother of Case 1, C. C., aged twenty-five, was examined and a normal structure of the bones of both wrists and hands, the pelvis, the right knee and the right foot were found.

A sister of Case 1, V. C., aged twenty-eight, was also examined and here again there was no evidence of the spotted structure in the long bones.

The illustrations of these cases may be seen by reference to the earlier article.[22]

The etiology is unknown but it is evident that there are more or less uniform disturbances in the proliferation and ossification of bone-forming cartilage during the period of development. Voorhoeve,[20] who reported 2 cases in 1924 and made an extensive study of this condition, stated that he believed the anomaly to be hereditary and that it should be placed in the group of dyschondroplasias.

To Schmorl[17] we are indebted for the greatest amount of information on this condition. He had the opportunity to make a post-mortem study, both grossly and microscopically. In 1931 he reported a case of osteopoikilosis in a boy eighteen years of age who had suffered from multiple osteomyelitis and had died from severe secondary anemia and amyloidosis. Autopsy study was made and the report by Schmorl is summarized as follows:

Serial microscopic examination of the spotted areas revealed that the increased density was the result of numerous bone trabeculae of various thicknesses arranged rather regularly, the bone resembling the structure of the spongiosa and not the cortex. The individual trabeculae were slightly thicker than those of the normal bone in that particular region. Because of this and their close arrangement, they gave the impression of a compact bone. The merging into the surrounding structures was gradual, the trabeculae disappearing among those of the normal spongiosa. The thicker trabeculae consisted of lamellous bone arranged mostly parallel, but in a few instances also concentrically around blood vessels, however without leading to the picture of typical osteoma.

No deductions can be made from the above microscopic findings concerning the genesis of the disease. An endochondral origin can be eliminated on the basis that the foci show no connection with the endochondral zone of growth. The most plausible theory is that of a congenital anlage.

We became interested in the hereditary nature of the etiology of osteopoikilosis. Awalischwili[3] reported that 6 brothers of his patient were examined and the condition had not been found. Mascherpa[9] reported that the brother and sister of his case had been examined and each showed slight signs of the disease. In our cases the disease was present in father and son and the disturbances observed were so uniform that the hereditary character of the lesion at once became apparent.

From the study of this condition we are led to conclude that it is a hereditary anomaly developing from a congenital cartilage anlage. We do not believe it can be truly classed as a malacic bone disturbance. To support this view we cite the following observations:

1. The bone structural changes, while having a generalized skeletal distribution, are limited to certain specific areas in the bones, namely the cancellous or spongy bone of the epiphyses and the metaphyses, that part of the bone which is developed by endochondral ossification.

2. The roentgen picture of the bones is not that of generalized lessening of the calcium content or halisteresis.

3. The blood salts of calcium and phosphorus which comprise the major portion of the bone salts are unchanged in quantity in osteopoikilosis.

4. The cases observed have not suffered any symptoms which could be definitely ascribed to the presence of the unusual foci of condensation of the bones.

5. Our cases showed a marked similarity of the disturbances in the skeletal system in the father and son, which we believe is evidence of a hereditary etiology.

BIBLIOGRAPHY

1. Albers-Schönberg. Eine seltene, bisher nicht bekannte Strukturanomalie des Skelettes. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1915–1916, *23*, 174–175.
2. Amundsen, P. A case of disseminated condensing osteitis. *Acta radiol.*, 1930, *11*, 120.
3. Awalischwili, G. Zur Kasuistik der Osteopoikilie. *Röntgenpraxis*, 1930, *2*, 831–833.
4. Bistolfi. Su di un caso di osteopecilia (osteite condensante disseminata). *Radiol. med.*, 1927, *14*, 1024.
5. Gluch, B. Ueber einen Fall von Osteopoikilie. *Röntgenpraxis*, 1929, *1*, 505–507.
6. Kahlstorf, A. Zur Kenntnis der Melorheostose (Léri) und der generalisierten Ostitis condensans oder Osteopoikilie (Albers-Schönberg). *Röntgenpraxis*, 1930, *2*, 721–732.
7. König, E. Osteopoikilie. *Chirurg.*, 1930, *2*, 875–878. Abst. in *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1930, *42*, 406–407.
8. Ledoux-Lebard, R., Chabaneix, and Dessane. L'ostéopoecilie; forme nouvelle d'ostéite condensante généralisée sans symptoms cliniques. *J. de radiol et d'électrol.*, 1916–1917, *2*, 133–134.
9. Mascherpa, F. Sulla osteopecilia. Un nuovo caso di osteopecilia a strie. *Radiol. med.*, 1931, *18*, 1014–1027.
10. Moreau, L. Sur un nouveau cas d'ostéite condensante généralisée (ostéopoecilie). *J. de radiol. et d'électrol.*, 1918–1919, *3*, 318–319.
11. Newcomet, W. S. "Spotted bones." Am. J. Roentgenol. & Rad. Therapy, 1929, *22*, 460–463.
12. Piergrossi, L. L'origine delle strie trasversali paraepifisarie da crescenza. *Rinasc. med.*, 1927, *4*, 452–454.
13. Piergrossi, L. Osteopecilia ed osteosclerosi. *Rinasc. med.*, 1931, *8*, 513–516.
14. Reiser, E. Osteopoikilie. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1931, *43*, 808.
15. Richarz. Multiple Kompaktaherde in der Knochenspongiosa. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1921–1922, *28*, 86–87.
16. Schéle, A. A case of a rare skeleton anomaly. *Acta radiol.*, 1921–1922, *1*, 536–539.
17. Schmorl. G. Anatomische Befunde bei einem Falle von Osteopoikilie. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1931, *44*, 1–8.
18. Steenhuis, D. About a special case of ostitis condensans disseminata. *Acta radiol.*, 1926, *5*, 373–374.
19. Van Pée, P. L'Ostéopoecilie et les ostéites condensantes. *Liégé méd.*, 1931, *24*, 937–946.
20. Voorhoeve, N. L'image radiologique non encore décrite d'une anomalie du squelette. Ses rapports avec la dyschondroplasie et l'osteopathia condensans disseminata. *Acta radiol.*, 1924, *3*, 407–427.
21. Watchel, H. Ueber einen Fall von Osteopathia condensans disseminata. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1919–1921, *27*, 624–625.
22. Wilcox, L. F. Osteopoikilosis. Am. J. Roentgenol. & Rad. Therapy, 1932, *27*, 580–584.

DISCUSSION

Dr. R. S. Bromer, Bryn Mawr, Pa. If osteopoikilosis which is a condensing osteitis of bone is included in this category, then why are not other condensing osteites of bone, such as the sclerosing osteitis of Garré, the melorheostosis of Léri and others also included? I would like to ask this question of Dr. Morse.

Dr. P. F. Morse, Detroit, Mich. In answer to an objection raised by Dr. Bromer to including osteopoikilosis in the category of "malacic bone disease," I might explain how both osteopoikilosis and marble bone disease got into this program. Dr. Evans and I discussed that point at the time the program was being made up. It was merely because some cases of osteopoikilosis came along and came to our attention, and were considered at the same time that the parathyroid subject was being actively considered, and the same thing was true of marble bone disease. Certainly osteopoikilosis and marble bone disease are not in general bone malacias in any true sense as the rest of this group are. I think Dr. Bromer is right in objecting to putting osteopoikilosis in any formal discussion of malacic diseases of the bone. I do not think it belongs there. Personally I have not seen anything that makes me think it is at all related to the parathyroid, but that does not make any difference because many of the malacic diseases of the bone are not related to the parathyroids. However, I think his remarks are pertinent and entirely correct.

MARBLE BONES*

By A. HOWARD PIRIE
Royal Victoria Hospital
MONTREAL, QUEBEC

MARBLE bone disease was first described by Albers-Schönberg in 1904. For ten years no other case was described. In 1914 von Schick described a case, and at isolated intervals other cases were described in the literature. At a meeting of this Society in 1923 Dr. William G. Alexander[1] reported a case. In 1929 I[2] collected 26 reported cases and reported 5 new ones, and in 1930 Kudrjawtzewa[3] reported 26 cases from the literature. In a study of 2,500 children Karshner established 4 cases. It is evident, therefore, that marble bones is a rare condition.

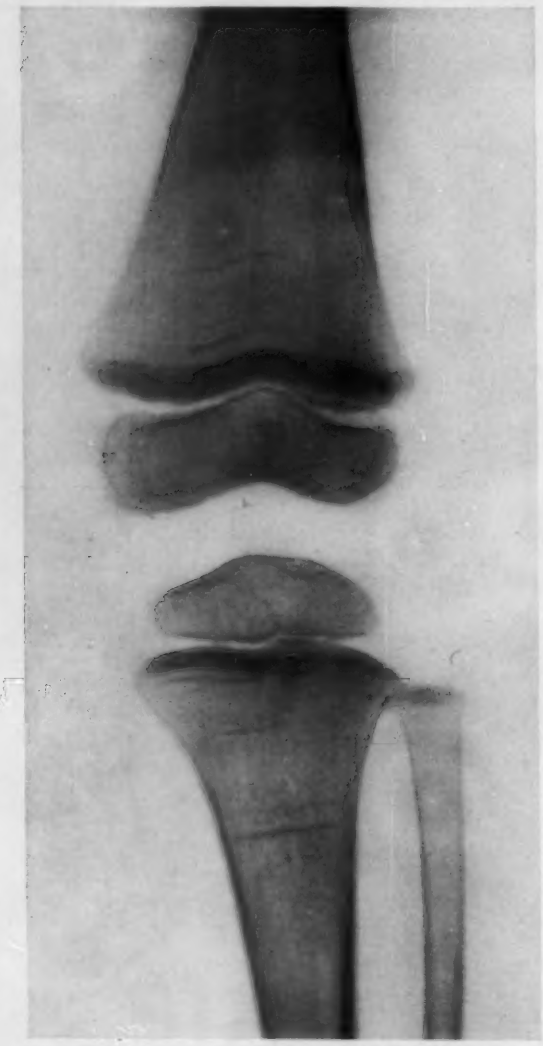


FIG. 1. Female, aged two and a half. This shows the dense line of lead poisoning which is indistinguishable from marble bones in an early stage. (Courtesy of Dr. Childe, Children's Memorial Hospital.)

Roentgen examination is necessary to establish the diagnosis, though a definite train of clinical symptoms has been established.

The changes in a fully developed case consist in the transformation of the spongy parts of the bones into solid compact tissue. The roentgenogram shows the bone white and structureless. The bones are brittle and break easily. The base of the skull is thickened, and the depth of the sella turcica is lessened. Where the spongy part of a bone is not sclerosed it exhibits osteoporosis with a wide meshwork of the trabeculae.

There is usually a blood change due to absence of the medulla of the bones. There may be anemia and enlargement of spleen, liver and lymph glands.

Cases have been reported from the age of three to forty-eight. The parents of children with marble bones may be free of the disease. A case is reported of a father and mother who were closely related, the man being uncle two degrees removed from the woman. They had children with marble bones. Each of these parents had been previously married, and each had had healthy children, yet when they united the mother

[1] Alexander, W. G. Quoted by Pirie.

[2] Pirie, A. H. The development of marble bones. Am. J. Roentgenol. & Rad. Therapy, 1930, *24*, 147–153.

[3] Krudrjawtzewa, N. Ueber Marmorknockenkrankheit. *Arch. f. klin. Chir.*, 1930, *159*, 658–687.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

bore children who developed marble bones. Consanguinity plays an important part in the appearance of the disease.

The bones change little in their shape, but there is a distinct tendency for the bones at the shoulder and knee to become club shaped, and for the surface of the bone there to grow fluted like a Corinthian pillar.

The disease is usually first recognized because of a fracture, which is the transverse type seen in a pathological fracture.

Fig. 2. Male, aged ten and a half. This shows the dense line produced by treatment for nine months with bismuth as antiluetic treatment. (Courtesy of Dr. Childe.)

Fig. 3. Marble bones at an early stage. Note the beginning of the marble-like appearance in the same place as in lead and bismuth poisoning.

It heals readily and callus forms freely. It is not so easy to recognize the early stages of the disease.

No case of intrauterine marble bones has been described. At a meeting of this Society about nine years ago I showed a slide of a fetus in a mother who had well developed marble bones, but this child six years later showed only slight evidence of marble bones. The condition seems to develop at an age when thickening appears in the metaphyses from other causes. For instance in young children with rickets and scurvy a thickening appears at the metaphyses when curative treatment is going on. The same is seen when excess of phosphorus is

fed to a growing infant. We see it also in lead poisoning, bismuth poisoning and strontium poisoning.

Some illustrations are included of lead

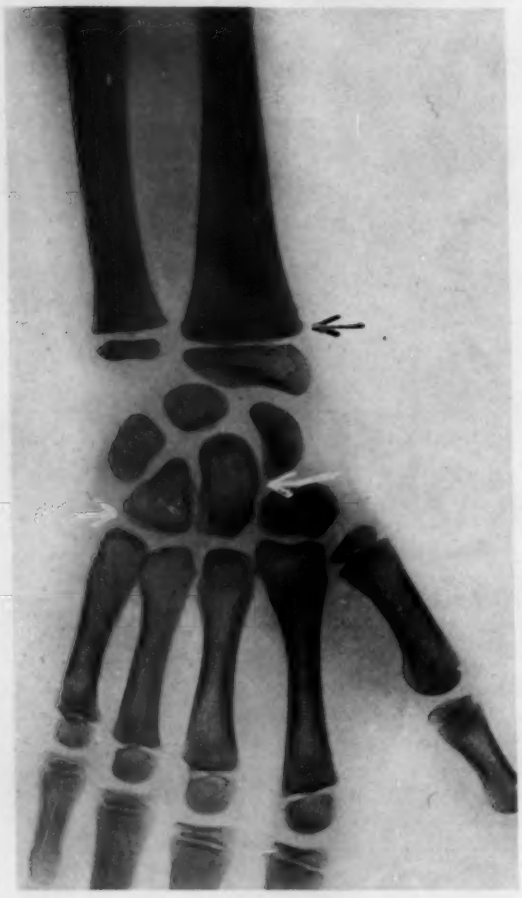


Fig. 4. Early stage of marble bone disease showing the circling of the carpal bones by a ring of dense bone.

poisoning (Fig. 1), and bismuth poisoning (Fig 2) supplied to me by Dr. Childe of the Children's Memorial Hospital of Montreal so that these may be compared with the early cases of marble bones (Figs. 3 and 4).

In the cases of poisoning by lead, phosphorus, strontium and bismuth, the cause must be withdrawn or the patient dies, but in the case of marble bones the patient does not die even though the cause is not withdrawn, and the sclerosis goes on till the whole bone is sclerosed.

The appearance of the short bones is also characteristic in the advancing stage as they are circled by dense bone (Fig. 4). This is seen in the tarsal and carpal bones, in the vertebrae and in the iliac bones. One should be familiar with these appearances in order to look for typical marble bones elsewhere. When marble bones is suspected one should examine the ends of the bones which grow most rapidly, for it is there that the disease shows itself best, namely, at the upper end of the humerus, at the ends of the tibia and femur, and at the knee joint.

Changes in the blood are frequent but inconstant in degree. The enlargement of the spleen, liver and lymph glands may be a compensating factor to supply the loss of the blood-forming function lost by the medullary cavity which becomes sclerosed.

Osteoporosis is recognizable in the roentgenogram and microscopically as an antecedent to the osteosclerosis of marble bones.

Chemical analysis of the bone shows little change. The calcium content is raised about 1 per cent and the phosphorus rather less, though the phosphorus content of the blood has been found raised in many cases. This may be an important influence in the production of marble bones, as experimentally a condition of marble bones has been produced in animals by overfeeding with phosphorus.

Fractures which are common in marble bones are characteristic. They may be painless. They are transverse and not splintered, in fact, they break as if the bone had been changed into chalk rather than into marble, and the dense bone can be worked upon with a drill as if it were chalk.

KASHIN-BECK'S DISEASE*

By A. HOWARD PIRIE
Royal Victoria Hospital
MONTREAL, QUEBEC

KASHIN-BECK'S disease fortunately does not occur in North America, and we are therefore unfamiliar with it. In order to complete this symposium on Malacic Diseases of Bone it has been added, and a short description of the disease is here presented, taken mainly from the works of Kashin and Beck and as described by Schipatschoff[1] of Irkutsk, Siberia.

A general idea of the disease may be obtained from photographs of persons suffering from it. Figure 1 shows a boy with hands very deformed by the disease, illustrating the bear's paw deformity of the hands. The bones are shortened and the joints are swollen. Figure 2 shows two patients with the disease fully developed. Note the deformities caused by shortening of the bones, changes in the joints and atrophy of muscles. Figure 3 shows two similar patients. Figure 4 shows the roentgen appearance of the head of the femur, with a normal femur for comparison. The appearance is similar to an advanced case of osteoarthritis. The gross specimens of the humerus (Fig. 4) show the shortening and deformities at the ends of the bones. A normal humerus is shown for comparison.

The endemic area is Siberia to the north of Manchuria, between the River Schilka to the north and the Argon to the south where nearly a million people exist.

Kashin described a disease in 1850 in the Transbaikal region of Siberia. He described it as a form of arthritis, and could only obtain cures by making the inhabitants of the affected area leave their homes and move to another part of the country.

As to the cause of the disease, Kashin said it developed in areas where syphilis, malaria or scurvy was present, which along with the raw climate, high position of the ground, bad ventilation in a valley shut in by high hills, and the condition of the water which was greatly contaminated by manure, were the chief causes of the disease.

FIG. 1. Kashin-Beck's disease showing the bear's paw deformity (after Schipatschoff).

Little notice was taken of his writing until Beck[2] in 1906, following the teachings of Kashin, pointed out that the water was the root of the whole trouble.

The clinical appearance of the disease is as follows: In the early stages it is not easy to diagnose. Pains in the joints, and tearing sensations in the muscles are the first symptoms; large and small joints are equal-

[1] Schipatschoff, W. G. Die Kaschin-Becksche Krankheit (Osteoarthritis endemica.) *Deutsches Arch. f. klin. Med.*, 1931, *170*, 133-145.

[2] Bek, E. V. Arthritis deformans in the province beyond the Baikals. *Russk. Vrach.*, 1906, *5*, 74.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27-30, 1932.

FIG. 2. Kashin-Beck's disease showing two patients with the disease fully developed (after Schipatschoff).

ly affected; the joints swell, hemorrhagic spots appear in the skin, the temperature rises accompanied by a profuse perspiration; in fact, it appears like acute joint rheumatism. The acute stage passes and deformities appear, which are chiefly at the ends of the bone; the disease is symmetrical, but the right side may be more deformed than the left. It is more frequent in men than in women. Children may be born with the disease. Atrophy of a muscle or group of muscles may occur. The extremities are often shortened, reminding one of a bear's paw. It is frequently associated with goiter. The gums are spongy, and bleeding takes place easily. Teething is late and children are rachitic. Rachitic rosaries are found and the development of the body is retarded.

The importance of dirty water as a cause of the disease was pointed out by both Kashin and Beck, and to prove this point experiments were carried out on young growing dogs which had drunk water out of the River Unda, which was greatly contaminated with manure. Arrest of growth followed and the dogs grew thin. Microscopic changes were found in bones, muscles, spleen, thymus, thyroid and other organs. The changes in the bone resemble arthritis, but there is marked rarefaction, and the cortex is thinned and the bones become shortened. There is a resemblance to rickets and scurvy; in fact, the disease appears to combine rickets, scurvy and polyneuritis, and Kashin in his original description said that scurvy passed into rheumatism. The changes already noted in human bones are found in animals in the endemic area, namely, cows, calves, sheep,

FIG. 3. Kashin-Beck's disease. Two front views of two patients with the disease (after Schipatschoff).

dogs, cats, hens and doves. Examination made of nine patients suffering from the disease showed greatest changes in the skeleton, and many histologic changes in the internal organs.

The disease may be due to want of vitamins, and to prove this theory chemical investigations were carried out by Professor Balladins in the Ukrainian Biochemical Institute. The wheat of the harvest of 1926 was analyzed, and increase was found in creatin, and a lack of mineral salts, and the vitamins were not sufficient for the proper growth of the animals. Bread taken from the endemic area produced changes in animals similar to those seen in man. Histological changes were also visible, and the bones changed as in Kashin-Beck's disease. The grain does not ripen properly owing to the cold climate and the high elevation of the endemic area, so formation of vitamins is lacking, or poison may be present in the unripe grain.

The one-sidedness of the nourishment of the inhabitants plays a rôle; they must do without vegetables for five to six months, therefore water and food are considered the real factors in the progress of Kashin-Beck's disease.

The prognosis of Kashin-Beck's disease is unfavorable when the patient remains in the endemic area, and the disease disappears without treatment when the patients move out of the area. If they remain in the district they become chronic invalids.

It is fortunate that in North America, at least up to the present, we have not experienced the discomforts which these people in Siberia have to encounter, and thus the disease is unknown here. One could imagine that a child suffering from scurvy

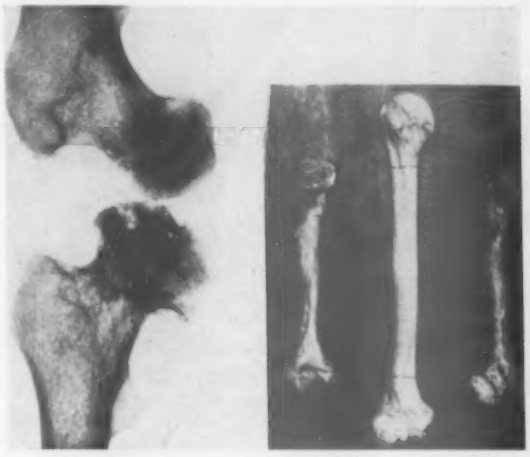


Fig. 4. Kashin-Beck's disease showing its resemblance to osteoarthritis (after Schipatschoff).

if kept alive and allowed to grow with a defective diet which would keep the disease progressing would develop such deformities as are seen in Kashin-Beck's disease. The diet of patients with Kashin-Beck's disease consisting of unripened grain, no vegetables, and polluted water, is not one likely to be used in this country so it is not surprising if cases of this disease are not seen here.

RENAL RICKETS*

By EDWARD C. VOGT, M.D.
BOSTON, MASSACHUSETTS

RENAL rickets is a term used to denote rachitic bone changes sometimes associated with chronic nephritis in children. It is not a primary entity, but a manifestation of disturbed mineral metabolism resulting from kidney disease.

This paper is concerned particularly with the question of its relation to rickets in general and with certain features of the bone lesions which are or may be of diagnostic significance.

Rickets as ordinarily seen in infants and as produced in animals is a deficiency disease, i.e., certain vital factors essential to the anabolism of bone are lacking.

McCollum and his coworkers[7] proved the existence of a specific calcifying substance which is known as vitamin D. It is present in some foods, particularly abundant in cod-liver oil and can be produced by irradiation of certain fats including those normally found in the skin.[3,4]

According to the work of Park, Guy and Powers,[10] this vitamin acts as a regulator of calcium and phosphorus metabolism and permits the organism to operate with greatly increased economy with respect to these minerals.

In rachitic infants, the inorganic phosphorus of the blood is usually considerably reduced. The calcium may be normal or only slightly diminished.[5] In some cases, however, the calcium is low and the phosphorus elevated.[15]

Shipley, Park, McCollum and Simmonds[13] showed experimentally that, in the absence of vitamin D, rickets could be produced either by diminishing the phosphorus in the diet and supplying an optimum or excess of calcium or by reducing the calcium and maintaining the phosphorus at or near optimal concentration.

These same investigators[8] brought out evidence to show that the ratio between calcium and phosphorus in the diet is of infinitely greater importance in insuring normal calcification than the absolute amounts of these salts. This point was recently emphasized by Bethke, Kick and Wilder.[1] The most favorable Ca:P ratio for growth and bone formation is between 2.00 and 1.00. The vitamin D requirements at these proportions is at a minimum.

Summarizing the results of some of their previous experiments, Kramer and Howland[6] state that the concentration of calcium and inorganic phosphorus in the serum is determined by at least four factors, namely, the calcium content of the diet, its total phosphorus, the ratio of these components in the diet, and the amount of vitamin D preformed or produced by irradiation. Without the balancing effect of vitamin D, the calcium and phosphorus in the serum varies directly with concentration of the same elements in the diet. Furthermore, there seemed to be an antagonism between calcium and inorganic phosphorus. A high concentration of one element depressed the other component in the serum.

Binger[2] had previously shown that the intravenous injection of phosphate solutions caused a drop in the serum calcium from normal of 10 mg. per 100 c.c. to approximately 6 mg.

The foregoing data as part of an extensive literature on the subject are quoted to show that the primary factor responsible for the bone changes of rickets is an imbalance or deficiency of calcium and phosphorus in the blood. The pathognomonic histological lesion is due to defective mineralization of growing bone.

It therefore seems reasonable to expect that any factor or factors that are capable

* From the Department of Pediatrics of the Harvard Medical School and the Roentgenological Department of the Infant's and Children's Hospital, Boston, Mass. Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

of sufficiently disturbing the levels of calcium and phosphorus in the blood can cause rickets to develop in growing bone.

Vitamin D is the regulator and economizer of these elements, but to say that its presence in sufficient or even excess amounts can always insure normal calcification would be contrary to experience. In other words, under some circumstances, calcium and phosphorus metabolism may be so disturbed that vitamin D cannot rectify it.

Kidney disease is recognized as one of the factors that serve to alter the levels of the inorganic constituents of the blood. Peters and Van Slyke[12] state that in cases of nephritis which present gross retention of nitrogenous waste products in the blood, the inorganic phosphorus of the serum is abnormally high, and whenever the inorganic phosphorus is consistently above normal limits, calcium is proportionately reduced.

Fig. 1. Case 1. Note the broad mottled zones at the lower ends of the femora, due to defective calcification and inclusion of cartilage islands. Infractions have occurred through this poorly formed bone. Compare with Figure 2.

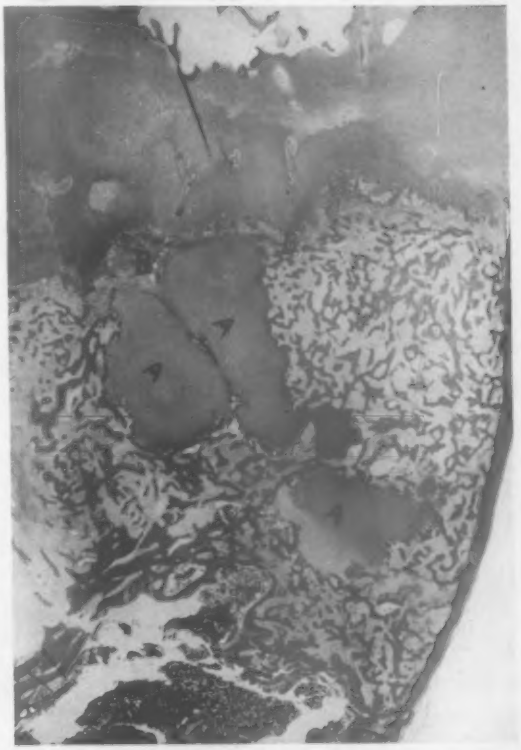


Fig. 2. Case 1. Low power photomicrograph from section through lower end of the right femur. A, A, A, large islands of uncalcified cartilage. Osteoid is relatively slight in amount. B, B, irregular zone of provisional calcification. There is an excess of fibrous tissue between the trabeculae.

Therefore, in certain types of nephritis conditions are present which are favorable for the development of rickets.

Quite recently Mitchell[9] thoroughly reviewed the subject of chronic nephritis in children. He states that small stature and stunted growth almost invariably accompany chronic kidney disease in early life. This stunting is sometimes referred to as renal dwarfism. Abnormal bone changes were recognized in only about 40 per cent of the cases which he collected.

From the standpoint of function, the

Fig. 3. Case 1. Roentgenogram of ribs, post mortem, showing irregular mottling of anterior ends and defective subperiosteal calcification along the lateral margins.

important feature is an advanced renal insufficiency; these children usually die in uremia, seldom reaching adult life.[11]

When examined post mortem, the common kidney finding is chronic interstitial nephritis or nephrosclerosis, but other conditions are also encountered, such as polycystic kidneys, pyelonephritis and defective kidney development. Calculi are also reported.

Detailed histological studies of the bones have been made in relatively few cases. That the changes may differ in some respects from those usually seen in rachitic infants is to be expected. Growth is retarded, so osteoid is less abundant and may be only slight in amount. By the time these patients die the condition has usually been present for a long time and the changes in the bones are chronic. There may have been alternate periods of healing or partial healing and relapse. Irregular islands of incompletely calcified cartilage become included in the poorly formed new bone while considerable fibrous tissue fills the interstices. This causes weakening where as the result of muscular activity and weight-bearing infractions are apt to occur.

The roentgenological changes correspond in a gross way with the microscopic picture. Findings vary a great deal in the different cases and sometimes in the same case at different times. Skeletal development is always retarded and growth disturbances are often manifested by the presence of transverse striae near the ends of the long bones. In some cases there is a zone of osteoid at the growing ends which is in no way different from that seen in ordinary rickets. Usually, however, there is something atypical about the picture. The lesions may be asymmetrical or different bones unequally involved.[14] When the process has existed for a long time, there is a deep mottled zone at the ends of the long bones consisting of osteoid, islands of cartilage, fibrous tissue and partially calcified matrix. Distortion, infractions and bizarre deformities result.

Teall[14] has called attention to superficial defects that sometimes occur along the shafts of the long bones, which he describes

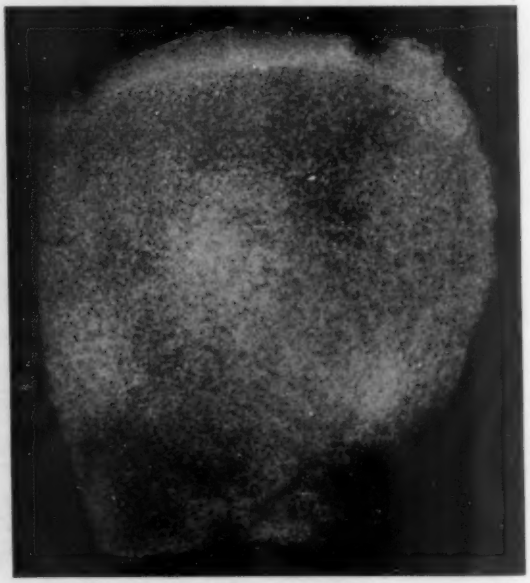


Fig. 4. Case 1. Skull plate, post mortem, showing fine granular mottling and generalized osteoporosis.

as an eaten away appearance, and considers a most important feature from a diagnostic standpoint. These as indicated by microscopic study and as judged by the roentgenological appearance are due to defective calcification of subperiosteal growth. This is comparable to the defective subperiosteal calcification commonly seen in ordinary rickets, and also sometimes seen along the diaphyseal margins of young patients with hyperparathyroidism.

Parsons[11] and Teall[14] have also described what they call a woolly appearance of the skull with marked thickening of the vault in advanced cases. Our cases have all shown generalized osteoporosis and finely granular cranial bones. The difference is probably a matter of degree or severity. Microscopically, there is a considerable amount of fibrous tissue dispersed between the bony trabeculae.

CASE REPORTS

Case I. L. R., white female, aged two and a half. She neither walked nor talked, and weighed 13½ pounds. Urine showed a trace of albumin and many pus cells. Blood N. P. N. 150 mg. per cent. Phenolsulphonphthalein elimination practically nil in two hours. Serum calcium 6.2 mg. per 100 c.c. and inorganic phosphorus 5.3 mg. Plasma phosphatase 9 units (normal 3).

Roentgenograms showed changes of chronic rickets which did not improve with 3 drams of cod-liver oil daily and she died after two months in the hospital.

Fig. 5. Case III. The zones of osteoid at the ends of the diaphyses are identical in appearance with ordinary rickets.

Fig. 6. Case V. Defective subperiosteal calcification at the upper ends of the tibiae medially, eaten away appearance. The metaphyses are smooth and dense.

Necropsy* revealed extensive bronchopneumonia. Kidneys were small, contracted and fibrotic with widespread chronic inflammatory cell infiltration in interstitial tissue. The parathyroids were hyperplastic but no adenoma present. Adrenals contained numerous microscopic intracortical adenomata.

Case II. A. S., white girl, aged nine, admitted on account of puffiness of face, headaches and convulsions. Symptoms dated back an indefinite period, probably to birth. She was anemic, undersized and mentally retarded. Urine showed a trace of albumin and many pus cells.

* Pathological report by Dr. Sidney Farber.

Phenolsulphonphthalein elimination almost nil. Blood N. P. N. 188 mg. per cent. Serum calcium 7.6 mg. per cent and inorganic phosphorus 5.6 mg. per cent. Roentgenograms showed a broad zone of osteoid at the ends of all the long bones, characteristic of rickets.

Case III. S. K., white girl, aged nine and a half, pale, weak and physically retarded. Was known to have albumin and pus in the urine for several years. Blood N. P. N. 200 mg. per cent. Died in uremia. No necropsy (see Fig. 5).

Case IV. S. B., white female, admitted first at eighteen months of age with fever, vomiting and pyuria. Pylograms showed a large hydronephrotic right kidney. The left, as proved by operation, was congenitally absent. Blood N. P. N. was 46 mg. per cent and phenolsulphonphthalein elimination less than 10 per cent in two hours. She first began to walk at 2½ years when it was noticed that her ankles turned in and she had knock-knees. Roentgenograms showed a broad zone of osteoid and mottled new bone at the lower ends of the tibiae and fibulae through which there were incomplete fractures. The epiphyses turned outward. There was also moderate mottling of the metaphyseal margins of the radii and ulnae. She had been getting cod-liver oil (amount not stated) but in the hospital with 3 drams daily and direct sunlight, the lesions definitely improved.

Fig. 7. Hyperparathyroidism in a boy aged fifteen. Roentgenogram (A) was made when the serum calcium was 19.4 mg. per 100 c.c. and inorganic phosphorus 4.0 mg. Note the rachitic zone of osteoid at the metaphyses and the generalized osteoporosis. Roentgenogram (B) was made four months after the surgical removal of a large parathyroid adenoma (3×4 cm.) and the serum calcium and inorganic phosphorus had returned to normal levels. The bones are now well ossified. (This case is presented through the courtesy of Dr. M. C. Sosman of the Peter Bent Brigham Hospital.)

Case V. R. S., white female, aged seven. Chief complaint was failure to grow and develop. Urine showed a trace of albumin. Blood N. P. N. 133 mg. per cent and renal function too low to be estimated. Serum calcium 10.1 mg. per 100 c.c. and inorganic phosphorus 6.9 mg. *Note:* This child did not have the typical zone of osteoid at the ends of the long bones, but she did have defective subperiosteal bone growth (Fig. 6).

DISCUSSION

For the diagnosis of renal rickets, two conditions have to be established, namely, rachitic bone lesions and chronic nephritis. The patient may first come to the attention of the physician on account of the skeletal deformities. More often, however, the chief symptoms point to renal damage.

Roentgenograms are of the greatest value in determining the nature of the bone changes in the living, but one is seldom warranted in making an etiological diagnosis from the films alone. If the bone lesions are atypical or if the patient is beyond the age when rickets usually occurs, suspicion should be directed towards the kidneys as a possible cause. Changes of rickets are sometimes found in the roentgenograms of children known to have chronic nephritis although they may not have been clinically recognized. Since the roentgen ray has come into general use as a diagnostic aid, cases are being reported more frequently.

Rickets resulting from kidney disease usually does not respond to the administration of vitamin D, but from some reported cases[3a] and from our own experience, it is probable that this substance may sometimes increase calcification. The kidney disease causes an imbalance of calcium and phosphorus in the blood. Vitamin D is a regulator of calcium and phosphorus metabolism. If the imbalance is not too great, vitamin D may correct it sufficiently to improve or even cure the rickets temporarily.

Further evidence that a severe imbalance of calcium and phosphorus of the blood even in the presence of vitamin D is seen in cases of hyperparathyroidism. Parathyroid disease occurs more often in the age period after growth has ceased, and then osteitis fibrosis osteoplastica (von Recklinghausen's disease) is the common manifestation in bone. However, if the bone is actively growing, rachitic changes may develop (parathyroid rickets).

Therefore, from the roentgenological standpoint, we have at least three conditions to consider in the differential diagnosis, namely, rickets the deficiency disease,* renal rickets and parathyroid rickets.

* Coeliac rickets as described by Parsons[11] would be included here under rickets the deficiency disease.

As evidence of renal disease, there is usually albumin in the urine and there may be pus. Functional tests show an advanced renal insufficiency and retention of nitrogenous waste products.

The inorganic phosphorus of the serum is increased. The calcium may be normal, but is often reduced. The ratio between these elements in the serum is always unbalanced.

In uncomplicated hyperparathyroidism, the serum calcium is much increased, and the inorganic phosphorus usually low.

The plasma phosphatase is high in all types of rickets.

The ultimate diagnosis depends on the correlation of all available data, including history, clinical, roentgenological and laboratory findings.

REFERENCES

1. Bethke, R. M., Kick, C. H., and Wilder, W. The effect of calcium-phosphorus relationship on growth, calcification, and blood composition of the rat. *J. Biol. Chem.*, 1932, *98*, 389–403.
2. Binger, C. Toxicity of phosphates in relation to blood calcium and tetany. *J. Pharmacol. & Exper. Therap.*, 1917–1918, *10*, 105–120.
3. Clouse, Ruth C. Vitamin D. *J. Am. M. Ass.*, 1932, *99*, 215–222; 301–309.

3*a*. György, P., and Schick, B. Quoted by Mitchell, ref. 9.

4. Hess, A. F., and Weinstock, M. The antirachitic value of irradiated cholesterol and phytosterol. *J. Biol. Chem.*, 1925, *64*, 181–191.
5. Howland, J., and Kramer, B. Calcium and phosphorus in the serum in relation to rickets. *Am. J. Dis. Child.*, 1921, *22*, 105.
6. Kramer, B., and Howland, J. Factors which determine the concentration of calcium and inorganic phosphorus in the blood serum of rats. *J. Nutrition*, 1932, *5*, 39–60.
7. McCollum, E. V., Simmonds, N., Becker, J. E., and Shipley, P. G. Studies on experimental rickets; an experimental demonstration of the existence of a vitamin which promotes calcium deposition. *J. Biol. Chem.*, 1922, *53*, 293–312.
8. McCollum, E. V., Simmonds, N., Shipley, P. G., and Park, E. A. Studies on experimental rickets; production of rickets by diets low in phosphorus and fat-soluble A. *J. Biol. Chem.*, 1921, *47*, 507.
9. Mitchell, A. G. Nephrosclerosis (chronic interstitial nephritis) in childhood, with special reference to renal rickets. *Am. J. Dis. Child.*, 1930, *40*, 101.
10. Park, E. A., Guy, R. A., and Powers, G. F. A proof of the regulatory influence of cod liver oil on calcium and phosphorus metabolism. *Am. J. Dis. Child.*, 1923, *26*, 103–111.
11. Parsons, L. G. The bone changes occurring in renal and coeliac infantilism, and their relationship to rickets; renal rickets. *Arch. Dis. Childhood*, 1927, *2*, 1–25. Also: Bone changes occurring in renal and coeliac infantilism, and their relationship to rickets; coeliac rickets. *Arch. Dis. Childhood*, 1927, *2*, 198–211.
12. Peters, J. P., and Van Slyke, D. D. Quantitative Clinical Chemistry. Williams and Wilkins Co., Baltimore, 1931.
13. Shipley, P. G., Park, E. A., McCollum, E. V., and Simmonds, N. Is there more than one kind of rickets? *Am. J. Dis. Child.*, 1922, *23*, 91–106.
14. Teall, C. G. A radiological study of bone changes in renal infantilism. *Brit. J. Radiol.*, 1928, *1*, 49–58.
15. Tisdall, F. F. The calcium and phosphorus concentration in the serum of infants with mild rickets or a condition simulating mild rickets. *Am. J. Dis. Child.*, 1922, *24*, 382–386.

DISCUSSION

Dr. P. F. Morse, Detroit, Mich. These cases of renal rickets are of extraordinary interest relative to the parathyroid question. A recent case on which I did a post mortem was a boy with a typical clinical history of hypertensive nephritis. At the post mortem the combined weight of the two kidneys was 65 grams. He was seventeen years of age. One kidney weighed 25 grams and the other 40. The skeleton everywhere could be excised freely with the knife without the aid of a saw. We cut his calvarium off with a large knife. We excised certain of the vertebral bodies. We cut out a big piece of the femur and of the arch of the pubes all freely with the knife without any grating or signs of lime salts left. That boy had the largest parathyroid we have ever seen, and incidentally extreme basophilia of the hypophysis. We regard both of those changes as compensatory.

Dr. Vogt has shown you what I believe to be absolutely the underlying feature of renal rickets, and that is a high blood phosphate. Albright and Howe and their coworkers have shown that a high blood phosphate experimentally introduced into young animals always produces compensatory hypertrophy of the parathyroid. The change here is probably hyperphosphatemia, and it usually leads to parathyroid stimulation, and then to the secondary effect. It is merely an interesting pathological entity.

Therapeutically considered, there is not much to be hoped for because by the time any of us see these cases the kidney changes have gone on to an extent which makes it impossible to consider any form of treatment whatever.

I think of the high blood phosphate as being the background for all the other things, and the parathyroid changes, and the hypophyseal changes, and the bone changes as resulting eventually from that high blood phosphorus.

Vol. XXX, No. 5

OSTEOGENESIS IMPERFECTA*

By RALPH S. BROMER, M.D.

Roentgenologist to the Children's and the Orthopedic Hospitals, Philadelphia, and the Bryn Mawr Hospital

BRYN MAWR, PENNSYLVANIA

OSTEOGENESIS imperfecta has been defined by Knaggs as the disease which is characterized by a congenital defect in the evolution of the osteoblast, and which is recognized clinically by defective ossification of the cranium and multiplicity of fractures resulting from trivial causes. Various synonyms have been employed in the terminology of this disease, such as fragilitas ossium, idiopathic osteopsathyrosis, osteogenesis imperfecta, periosteal aplasia, maladie de Lobstein, and so forth. Various classifications of types and forms have been suggested. Prussak and Mesz state that the late variety of the disease was known before Lobstein (1833) described it as the latter cited several other authors, but credit is due him for giving it a definite place in medical literature and for presenting the first anatomical description of the condition. He regarded the fragility of the bones as a symptom of other conditions, suspecting carcinoma, rickets, scurvy and gout as possible underlying causes.

PATHOGENESIS

Practically all authors are agreed that the main and essential histological finding is a deficiency of osteoblasts, resulting in deficient ossification of bone, this being productive of numerous and repeated fractures. On chemical analysis there is no lack of the inorganic constituents of bone, and fragility cannot therefore be dependent upon this factor. The cause of the fragility must be sought elsewhere.

Since this paper forms a part of a symposium on the osteomalacic diseases of bone, calcium and phosphorus metabolism is naturally first thought of in connection with the pathogenesis of the condition. Wyatt and McEachern (1932) have lately reported a case in which there was marked congenital bone dysplasia and unusual vascularity of the parathyroid glands with a relatively small amount of parenchymal tissue, and they suggest the possibility that osteogenesis imperfecta may sometimes be based in part on a congenital parathyroid disturbance. This is apparently the sole reference in the literature to an actual pathological finding in the parathyroids in such a case.*

Bookman (1914) reported a slight decrease in the calcium retention as compared with the normal in a study of a patient, aged ten weeks, but a positive calcium balance was still maintained. Wagoner (1924) reported normal calcium and phosphorus content of the blood plasma and normal content of inorganic salts of the bone of the biopsy specimens removed from his patient. Flagstad, Zanger and Leven (1924) in a preliminary study also reported normal phosphorus and calcium values of the blood serum. In Wyatt and McEachern's case, no complete study of the calcium balance could be made. The content of calcium and phosphorus in the bone ash and the ratio between them were normal. The definite increase in the amount of sodium in the ash suggested to them a relative decrease in the amount of calcium phosphate per unit of bone. On the presumption that

* Since this was written, my attention has been drawn to the paper of Donald Hunter on "Calcium and Phosphorus Metabolism," *Lancet*, 1930, *1*, 999–1008. He states: "In osteogenesis imperfecta no abnormality in the serum calcium, plasma phosphorus or calcium output has been satisfactorily demonstrated. The plasma phosphatase is in some cases, slightly raised. The cause of the defective osteoblastic apposition of bone is quite unknown. There are two cases recorded which showed enlargement of the parathyroids. The seven month foetus described by Bauer had four enlarged parathyroids, the largest, the size of the adult gland, (3 mm. diameter). Histologically, these showed hyperplasia. He relates that Dietrich described another case. In the present state of our knowledge such observations are without explanation."

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

the bones never had their normal content of calcium salts, they suggest that possibly this factor could explain calcium and phosphorus levels in the blood which differ from those usually found in the parathyroid disturbance of later life.

Fig. 1. Osteogenesis imperfecta congenita. Typical "gnarled" appearance of the bones of the extremities. Deformities due probably to intrauterine fractures.

Before the publication of Wyatt and McEachern's case, the deficiency of osteoblasts was emphasized as a causative factor by most workers. Knaggs summarized the histological changes as follows: (1) the stages of cartilaginous ossification are normal up to the formation of the primary areolae; (2) the periosteal and medullary ossification is quite abnormal in character, deficient in quantity and inferior in quality; (3) osteoblast edging to the trabeculae is either absent altogether or only partially present. In the long bones, he drew attention to three important variations from normal: (1) in the formation of bone from the cartilaginous epiphysis the first departure from the normal process of ossification is the formation of trabeculae by the calcification of the cartilage and their extension by metaplasia of the adjoining connective tissue of the marrow; (2) intimately associated with this, and without doubt the cause of it, is the complete absence of rows of osteoblasts; (3) in the formation of bone under the periosteum is found the factor of the production by the periosteum of cartilage cells instead of osteoblasts.

Fairbank (1930) questions these causative factors, inasmuch as osteoblasts are found in the callus formed about the pathological fractures. He thinks the large cartilage cells formed by the periosteum instead of osteoblasts are no more than an occasional change, found here and there; nor does he regard it as strange for these cells to be present in large quantities since the periosteum itself is derived from the perichondrium, and cartilage cells are presumably derived from the periosteal cells found in callus of all ages.

The apparent lack of osteoblast formation has led to the theory of a congenital malformation of the bone-forming system, the disturbance occurring as a fault in mesoblastic differentiation inasmuch as osteoblasts, themselves connective tissue cells, are derived from the primary mesoderm. Knaggs so regards it and Weber (1930), more recently, has claimed that the formation of lamellar bone does not occur. The arrest of growth is a primary condition and the highest stage of bone development is entirely lacking. The origin of this growth disturbance is traceable far back into the intrauterine period. It differs from osteitis fibrosa cystica in that the latter involves a formerly normal skeleton and is thus a secondary dystrophy, whereas osteogenesis imperfecta is a congenital primary generalized arrested malformation of the bone-building system.

Endocrine disturbance, other than the parathyroids, has been suggested as a possible cause. Against this theory, however, is the fact that no pathological changes have been found in the thyroids and in other endocrine glands at autopsy. As Foote (1927) has pointed out, the hereditary nature of the disease is an argument against the endocrine theory since such failure

would have to be functional in the absence of actual reported pathological changes in the endocrine glands at autopsy. Functional disability of organs does not seem to be an inheritable trait. Gorter found that rapid improvement of symptoms followed treatment with thymus in two cases, using in one, fresh pig thymus and in the other compressed thymus gland. Ryan (1932) reported two cases, the patients having ceased to have fractures while thymus extract was administered. No metabolic studies were made, however, during the course of treatment. Fairbank has offered the suggestion that further work with phosphatase may throw some light on the pathogenesis of the condition.

Fig. 2. Male, aged five months. Numerous fractures of the long bones and ribs. Negative blood Wassermann. Apparently osteogenesis imperfecta, although the dense bands at the diaphyseal extremities resemble somewhat marble bones or Albers-Schönberg's disease, which is included by Fairbank under the general heading of osteogenesis imperfecta.

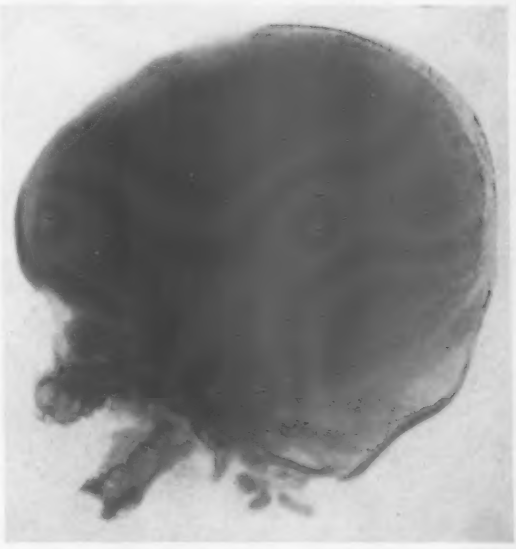


Fig. 3. Skull of same patient as Figure 2. Irregular ossification along the suture lines producing a mosaic appearance as described by Knaggs.

CLASSIFICATION

The disease appears at various periods of life, with varying degrees of severity and with varied clinical manifestations. Thus, clinical and pathological classifications also vary. Knaggs describes the fetal, the infantile, the childhood and adolescent varieties and finally the type found in later middle life. From a pathological standpoint, Fairbank classifies the disease into the thick bone type; the slender, fragile bone type; the marble bone type (Albers-Schönberg's disease) and the honey-comb type.

Key mentions three idiopathic types of bone fragility: (1) osteopsathyrosis described by Lobstein in 1833 as a clinical entity; (2) osteogenesis imperfecta described by Vrolik in 1849 as a separate condition; (3) the syndrome of brittle bones and blue sclerae described by Spurway in 1894. The accompanying symptom of blue sclerae will be more fully discussed later. Key uses this symptom as a basis for his classification inasmuch as he regards it as evidence of congenital hypoplasia of the mesenchyme. He divides the condition into the following types:

Fig. 4. Osteogenesis imperfecta tarda. Male, first fracture at two and one-half years of age. Has been under observation five years. Marked rarefaction and atrophy of the bones of the extremities. Blue sclerae. Mother also has blue sclerae with tendency to fracture on slight provocation. Normal serum calcium and phosphorus. Has been admitted to hospital four times for fractures of various bones.

1. Hereditary form, hereditary hypoplasia of the mesenchyme.

2. Non-hereditary forms: (*a*) osteogenesis imperfecta; (*b*) osteopsathyrosis with white sclerae; (*c*) osteopsathyrosis with blue sclerae.

3. Probably not hereditary, osteosclerosis fragilitas generalisata or marble bones.

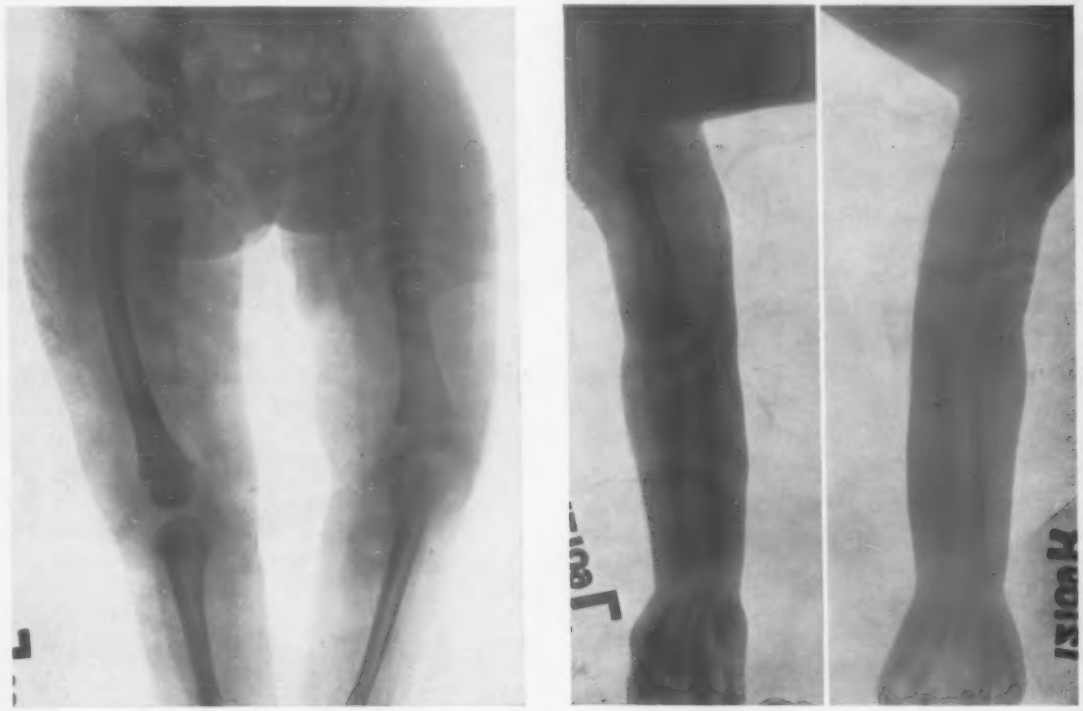
Osteogenesis imperfecta of the congenital type is regarded by him as not hereditary. No case of osteogenesis imperfecta has been recorded in any one of the families afflicted with hereditary hypoplasia of the mesenchyme. This latter seems to him to be an anomaly of development rather than a derangement of metabolism. The hypoplasia is apparently limited to those tissues derived from the mesenchyme. He has never found any evidence of endocrine disturbance. He thinks it better to regard osteogenesis imperfecta and idiopathic osteopsathyrosis as separate conditions because they present different clinical pictures although they may have the same pathologic basis. From his analysis of the literature he finds that blue sclerae are the only feature of hereditary hypoplasia of the mesenchyme which is transmitted as a dominant hereditary trait.

Osteogenesis Imperfecta Congenita. In this form the patient shows at birth evidence of the disease, the majority being born with numerous fractures. The extremities are usually deformed, noticeable immediately after birth; curvatures and nodular prominences are present. The thorax is often misshapen and nodules, due to the presence of intrauterine fractures with callus formation, can be palpated. The nodules felt in the long bones are due to the same cause. Occasionally crepitations can be obtained. The skull on pressure is no thicker than parchment due to defective membranous bone development. Fairbank describes it as a membranous bag with a few small isolated areas of ossification. This has led to the term "rubber-ball head." Knaggs calls attention to the fact that the membranous areas which intervene between the immature bones are apt to become filled with numerous Wormian bones resulting from discrete patches of ossification. Remarkable appearances, he says, are thus produced, the vault being represented by a mosaic of larger and smaller bone plates, sometimes touching one another and sometimes united by bridges of periosteum and dura. Often, there is such a noticeable degree of lack of ossification that the skull can be moulded by the pressure of the hands. Its shape is not that of hydrocephalus nor do the skull and facies resemble those typical of achondroplasia. The nose is not short and stubby and the features are not coarse. There is no excessive subcutaneous fat over the bones and the skin does not lie in deep folds. The stem length of the infant is usually normal for its weight but the general body length is always below normal. If the child lives, profuse and continued sweating, beginning usually during the second week, is present. Petechial hemorrhages of the skin sometimes occur. Cyanosis as a symptom often develops and there may be a moderate rise

in temperature. If the infant does survive, he remains a chronic invalid during the rest of his life. Some cases show a cretinoid cast of countenance. In this category may be included the cases which show less severe symptoms at birth and survive for a year or two. By some authors these cases are classified under the heading, osteogenesis imperfecta infantilis, or the infantile type. It seems far simpler to include as osteogenesis imperfecta congenita all cases, whether or not they survive, who have shown signs of the disease at birth, or so soon after, that no doubt exists that defective intrauterine ossification was present.

Osteogenesis Imperfecta Tarda. Under this can be classed all cases variously described as fragilitas ossium, osteopsathyrosis, adolescent osteogenesis imperfecta and the type occurring in middle or later life. Foote describes an infantile type that appears after the child begins to walk or stand without support. These children usually die comparatively early as a result of intercurrent infection. Very slight trauma may produce a fracture. As a rule, the earlier in life the fractures first occur, the greater is the liability to fracture. The fractures are usually subperiosteal and deformity is very likely to result from malposition of the fragments. There is a noticeable lack of pain which is probably accounted for by the subperiosteal nature of many of the fractures. Knaggs believes that in the cases in which the signs first appear in childhood or adolescence, the fundamental change was present in early uterine life. The less the defect, the greater is the likelihood that its signs will be delayed until the patient is able to get about and is exposed to the ordinary slight traumatisms of the usually healthy life.

The late form which does not appear in infancy or early childhood, but is seen first



Figs. 5 and 6.—Osteogenesis imperfecta tarda. Female, first admission for fracture of the femur at age of eight months. Readmitted at two and one half years of age for fractures of femur and ulna. No blue sclerae nor hereditary history. Normal serum calcium and phosphorus. Child died of pneumonia at four years of age.

in early adolescence or later life, usually has an accompanying history of distinctly hereditary character. This may be due to the fact that more of these individuals live to a marriageable age. In some the tendency to fracture may be slight, in others it may be more pronounced. Severe cases often must spend their lives in a wheel chair. In the late form, the tendency to angulation and extreme bowing of the bones is sometimes not so marked. This, however, is variable inasmuch as bowing depends upon the number of fractures incurred by the individual.

An accompanying symptom of osteogenesis imperfecta tarda, in many cases, is the occurrence of blue discoloration of the sclerae. This is usually described as grayish-blue. Griffith and Mitchell credit Eddowes (1900) with the first mention of the blue sclerae, but Prussak and Mesz state that Ammon, an eye surgeon, had described it earlier, in 1891. The trait is often found in several members of the family, and sometimes in more than one generation. In each one who shows the blue discoloration, a history of multiple fractures can usually be obtained. The blue color (Knaggs) is due to the partial visibility of the pigmented choroidal tunic through the sclera. The cause of this color is still unsolved. It has been suggested that the fibrous tissue of the coat is abnormal and this tissue, arising from the mesoderm as do the osteoblasts, is affected by the same disturbance. Bronson has noticed a liability to sprain of joints in cases having blue sclerae with multiple fractures. Here, too, would be another connective tissue similarly affected. Fairbank warns that the term should be limited only to those cases in which definitely blue sclerae are noted. He has been able to find no relation between the depth of color of the sclerae to the number of fractures or to the severity of the disease. Max Schmidt (1925) proposed the term leptoscleria for the blue discoloration, because the use of the word "blue" suggests an actual blue color such as may be noted in cases of carbolic poisoning and alkaptonuria, while leptoscleria expresses the true condition, the extreme thinness of the membrane. Buchanan (cited by Blevgad) states that the coat is sometimes only one-third its normal thickness, and the blue appearance is due to the blood of the uvea shining through it.

Among other associated symptoms, Blevgad and Haxthausen have reported a case of a patient with blue sclerae, tendency to fractures, and in addition, zonular cataract and circumscribed atrophy of the skin.

Deafness is another associated symptom. It seems, however, from the cases reported in the literature, that this is not as frequent as the blue discoloration. The reason for this is most likely the fact that disturbances of hearing arise only after the age of puberty is reached. Most authors attribute it to an otosclerosis, but Le Mee thinks that it is due to the deformity of the skull which causes a slanting projection of the membrana tympani accompanied by relaxation of the ligaments of the ossicles of the ear.

PATHOLOGY

The essential histological changes have been described. The lack of ossification in the skull is more marked in the vault although the same change can be found to a lesser degree in the base. The facial bones are largely cartilage. The vertebrae and the pelvic bones do not fracture as easily as the skull, long bones and the ribs. The periosteum is thickened in the region of the fractures but is normal elsewhere. There is not much cancellous bone in the ends of the shaft. Foote points out that in the congenital form, if the patient survives, most of the abnormality centers in defective transverse growth unless epiphyseal separations occur.

ROENTGENOGRAPHIC APPEARANCE

In the congenital form the roentgen appearance of the entire skeleton is characteristic. The bones of the extremities have a gnarled, stubby, and thickened appearance. The cortex is thin. Callus deposits can easily be detected in the shafts at the site of fracture. The bones are bowed and mis-

shapen. The thorax is sometimes compressed and the ribs are bent, due to the numerous fractures. All bones usually show a marked degree of osteoporosis with the exception of the vertebral column. The tables of the skull are extremely thin and often calcification and ossification seem to be entirely lacking in some areas. Small indentations due to fractures are visible. There is sometimes a noticeable lack of calcification in the bones of the face, and the cartilage shadows can be detected in roentgenograms showing excellent soft part detail. Sutures and fontanelles are wide.

In the late form there is usually marked thinning of the cortex and bowing of the long bones of variable degree. Generalized

Fig. 7. Osteogenesis imperfecta tarda. No hereditary history nor blue sclerae. Normal serum calcium and phosphorus. Right femur broken ten times; left femur, twice; right humerus, three times; left arm, twice. Fractures united quickly with excellent callus formation.

Fig. 8. Same case as Figure 7. Marked atrophy of the bones of the lower legs. Widening of the metaphyses and epiphyses.

osteoporosis may be present. The marked atrophy of the shafts produces an appearance of widening of the metaphyses and epiphyses. This, however, is often more apparent than real, the illusion being created by the atrophy of the shafts. As a rule, the epiphyses are not widened. In the cases of this series the so-called foamy epiphyses, supposedly characteristic of this disease were lacking. The area of the diaphyso-epiphyseal junction is usually normal. Where epiphyseal separations have occurred there may be periosteal proliferation along the borders of the epiphyseal centers of ossification, but this also has not been noticed in this series of cases. Slight infractions of the periosteum occasionally can be seen. On later examinations callus form-

ation occurs in these areas. Transverse striations, small fine lines running through the metaphyses of the long bones, are sometimes noticed. In patients having fewer fractures, bowing and deformity are not so marked and often the only bone change is a noticeable atrophy as shown by the thinning of the cortex.

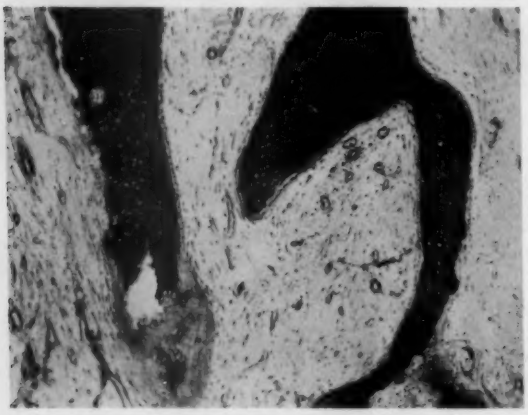


Fig. 9. Same case as Figure 7. Microscopical sections by Dr. Geo. W. Wagoner, Orthopedic Hospital; removed from femur near site of fracture. Osteoblast edging is present without the extreme lack of osteoblasts which usually occurs in osteogenesis imperfecta. Considerable fibrosis with a few giant cells; in many respects the appearance resembles osteitis fibrosa cystica.

DIFFERENTIAL DIAGNOSIS

From the roentgenographic point of view, there should be no difficulty in differentiating both the congenital and early infantile cases from rickets. The frayed-out diaphyseal extremities, the cupping, the moth-eaten appearance of the epiphyseal centers and the thinly striated shafts are not seen in osteogenesis imperfecta. The age incidence is also of importance as true fetal rickets has only been demonstrated in infants born of mothers suffering from osteomalacia. In the cases reported by Maxwell, Hu and Turnbull the roentgenograms showed no signs resembling those of the congenital type of osteogenesis imperfecta.

Achondroplasia presents the same short, thickened bones as osteogenesis imperfecta but multiple fractures, callus formation, etc., are lacking in the roentgenogram. Clinically the latter is characterized by the large head with the saddle nose and thick, coarse features, whereas with osteogenesis imperfecta the infant has a small head of rubber-ball consistency and the facies are normal.

Congenital syphilis must be differentiated from osteogenesis imperfecta. Usually the fetus with widespread syphilitic changes in the skeleton in the roentgenogram has also more or less definite clinical signs. The roentgenographic changes of congenital syphilis are so characteristic that no difficulty should be encountered. Usually in the ends of the diaphyses of the long bones the typical changes of syphilitic osteochondritis can be found, such as increased density and width of the zone of temporary calcification, submetaphyseal rarefaction (McLean), double zones of temporary calcification, and in the late stages, fragmentation and disintegration of the metaphysis in the area adjacent to the zone of temporary calcification. Besides, numerous fractures do not, as a rule, occur in congenital syphilis.

From the later form of osteogenesis imperfecta, juvenile osteomalacia can be diagnosed clinically by the negative calcium balance. In osteomalacia, the deformity, as a rule, precedes the fracture; in osteogenesis imperfecta, the fracture precedes the deformity. The occurrence of osteomalacia in adolescence has never been proved and according to most authorities it should not be considered a disease of infancy and adolescence. The history, etc., together with the negative calcium balance should be diagnostic in cases which occur after full growth is attained.

Finally, a differentiation must be made from the "osteopsathyrosis due to avitaminosis." Heise has lately described a case of infantile scurvy accompanied by multiple fractures. He attributes the latter to the condition termed osteopsathyrosis due to avitaminosis first described by Czerny and Keller. This can occur either alone or in

connection with other diseases such as rickets and infantile scurvy in which there is a deficiency of vitamins. It has no apparent relation either to the congenital form of osteogenesis imperfecta or to the late form, idiopathic osteopsathyrosis.

COMMENT

This report is based upon a series of 4 cases of the early or congenital type and 4 cases of the late or tarda type. Of the 4 congenital cases, only one showed a slight bluish discoloration of the sclerae. Of the late cases, one patient showed this sign, whose mother also had blue sclerae and a history of tendency to fracture on slight provocation. In none of them was deafness observed, probably due to the fact that they had not reached adult life. In one of the cases, metabolic studies are to be published later. Since this symposium is concerned with the roentgen appearance and diagnosis of this condition, its treatment has not been mentioned.

One of the outstanding points in the roentgenographic appearance of the cases studied was the absence of widened and foamy epiphyses, entirely lacking except for a slight tendency in one case (Fig. 7). Another point is the appearance of wide dense bands near the diaphyseal extremities which resembles that of marble bones or Albers-Schönberg's disease. This case would seem to justify the inclusion by Fairbank of marble bones as one of the groups or types of this disease entity. In one of the congenital cases calcium deposition occurred along the irregular and serrated suture lines of the skull, as described by Knaggs, producing an appearance of numerous, small islands of calcification, which suggests that this, in a certain proportion of cases, is a characteristic roentgen picture of the disease in the congenital type.

I wish to express my appreciation to Dr. Joseph Stokes, Children's Hospital, Dr. Vincent Curtin of the Episcopal Hospital, Dr. Deforest P. Willard and Dr. Geo. W. Wagoner of the Orthopedic Hospital for permission to study the cases taken from their services, and to Dr. Geo. W. Wagoner and Dr. Irvin Stein, Orthopedic Hospital, for their help and suggestions in the preparation of this paper.

REFERENCES

1. Bookman, A. The metabolism in osteogenesis imperfecta with special reference to calcium. *Am. J. Dis. Child.*, 1914, *7*, 436–444.
2. Bronson. Quoted by Knaggs, ref. 11.
3. Czerny and Keller. Die Kindes Ernährung, etc., 1925. Quoted by Heise, ref. 10.
4. Eddowes. *Brit. M. J.*, 1900, *2*, 222. Quoted by Griffith and Mitchell, ref. 9.
5. Fairbank, H. A. T. Some remarks on osteogenesis imperfecta. *Proc. Roy. Soc. Med.* (*Sect. Dis. Child.*), 1930, *23*, 77–84.
6. Flagstad, A. E., Zanger, E., and Leven, L. Blood chemistry in osteogenesis imperfecta; preliminary report. *Minnesota Med.*, 1924, *7*, 800–804.
7. Foote, J. A. Clinical Pediatrics, Diseases of the Bones, Joints, Muscles and Tendons, Vol. VII. D. Appleton and Co., New York, 1927.
8. Gorter. Quoted by Fairbank, ref. 5.
9. Griffith, J. P. C., and Mitchell, A. E. The Diseases of Infants and Children. W. B. Saunders Co., Philadelphia, 1927.
10. Heise, A. On the identity of imperfect congenital osteogenesis and idiopathic osteopsathyrosis, and on the diagnosis of the latter from infantile scurvy. *Acta radiol.*, 1932, *13*, 319–328.
11. Knaggs, R. L. Osteogenesis imperfecta. *Brit. J. Surg.*, 1923–1924, *11*, 737–759.
12. Le Mee. Quoted by Prussak and Mesz, ref. 16.
13. Lobstein, I. Traité d'anatomie pathologique. T. II. Paris, 1833. Quoted by Prussak and Mesz, ref. 16.
14. Maxwell, J. P., Hu, C. H., and Turnbull, H. M. Foetal rickets. *J. Path. & Bacteriol.*, 1932, *35*, 419–440.
15. McLean, S. The correlation of the roentgenographic and pathological aspects of congenital osseous syphilis, with particular reference to the first months of life. *Am. J. Dis. Child.*, 1931, *41*, 363–395.
16. Prussak, L., and Mesz, N. Ueber die idiopathische Osteopsathyrose. *Acta radiol.*, 1930, *11*, 175–193.
17. Ryan, W. J. Osteogenesis imperfecta. *J. Bone & Joint Surg.*, 1932, *14*, 939–942.
18. Schmidt, M. Quoted by Heise, ref. 10.
19. Wagoner, G. W. Idiopathic osteopsathyrosis (fragilitas ossium). *Ann. Surg.*, 1924, *80*, 115–123.

20. Weber, M. Osteogenesis imperfecta congenita. *Arch. Path.*, 1930, *9*, 984–1006.

21. Wyatt, T. C., and McEachern, T. M. Congenital bone dysplasia (osteogenesis imperfecta) associated with lesions of the parathyroid glands. *Am. J. Dis. Child.*, 1932, *43*, 403–415.

DISCUSSION

Dr. A. H. Pirie, Montreal, Quebec. The slide that Dr. Bromer showed seemed to me like a mixture of marble bones and osteogenesis imperfecta. I would like to have more information before expressing an opinion on that. Was that child under long continued treatment when the picture was taken?

Dr. Bromer: No, he is just five months old, and is a miserable specimen. He is all deformed.

Dr. Pirie: Were the parents closely related?

Dr. Bromer: I can't answer that.

Dr. Pirie: Was the phosphorus increased in the blood?

Dr. Bromer: No, normal.

Dr. Pirie: I think I would like to call it "Bromer's disease."

Dr. P. F. Morse, Detroit, Mich. We have been very much interested in this question of the relationship of osteogenesis imperfecta to parathyroidism. We had a very typical case within the past year of osteogenesis imperfecta, but which, as I remember, had a completely normal laboratory bill of health. Because of the large number of pathological fractures we felt justified in operating, and Dr. Ballin can tell you the results of that procedure in this particular case. I am not familiar with the clinical details. On theoretical grounds I do not consider osteogenesis inperfecta to have a relation to parathyroidism, but to represent a congenital familial mesoblastic defect. The defect is in the stroma and groundwork of the bone and not in the calcium or phosphorous metabolism.

Dr. Max Ballin, Detroit, Mich. I was much interested in the Doctor's remarks in which he stated that you do not have to take out the parathyroid but by interference with cervical ganglia the same thing can be accomplished. One French author has gone still further and claims any surgical interference around the thyroid region will benefit such cases. The question arises now whether these surgeons who prefer to do a ganglionectomy or just mutilate some tissue around the thyroid in reality interfere with the parathyroid, or whether the parathyroidectomy interferes with the cervical ganglia.

I am very doubtful about this, at least in a few cases, myself. For instance, in the case that Dr. Morse mentioned we did not find any traces of parathyroid, but removed a large thymus remnant from the parathyroid region. In spite of this the orthopedic surgeon in charge of the case tells me that after this operation the many fractures unite now and deformities resulting from the non-union can yield to orthopedic treatment.

This is a conference to discuss the extent of parathyroidism. The pendulum may swing too far and entities may have been taken in not belonging there, but only actual experience and exchange of well-founded opinions will set us right.

Vol. XXX, No. 5

THE RELATION OF THE THYROID, THE ADRENALS AND THE ISLANDS OF LANGERHANS TO MALACIC DISEASES OF BONE*

By ROSS GOLDEN, M.D., *and* HODSON ABBOTT, M.D.
NEW YORK CITY

THYROID

I. Hyperthyroidism.

THE association of hyperthryoidism with a decalcifying disease of bone was first reported by Köppen in 1892. Von Recklinghausen, who performed the necropsy, made a diagnosis of osteomalacia. Köppen thought the decalcification was produced by a vasomotor disturbance in the bone and was not the same as ordinary osteomalacia.

Of a total of 150 cases of osteomalacia, Latzko (1901) found 6 in which hyperthyroidism was present. He believed the thyroid dysfunction affected the bones through the intermediary of the ovaries.

Hoennicke (1904) attributed the decalcification observed in thyrotoxicosis to a disturbance in phosphorus metabolism. He pointed out what he believed to be the similar geographical distribution of goiter and osteomalacia. This was denied by Bossi (1907) who stated that in the region in Italy where there is much osteomalacia there is no goiter. He saw 37 cases of osteomalacia without goiter and many goiters in pregnant women without osteomalacia.

Tolot and Sarvonat (1906) reported a case of hyperthyroidism and osteomalacia. They had found 11 observations in the literature on the relation of these two conditions but were unwilling to accept the thyroid disturbance as the cause of the bone disease.

Von Jaksch and Rotky (1908) attributed the decalcification, softening and bending of the bones of a twenty-year-old girl to long-continued hyperthyroidism but did not believe it was true osteomalacia. Bernhardt (1927), recording a similar case, stated his belief that osteomalacia is a pluriglandular affair in which one or another gland may be primarily involved.

Curschmann (1919) reported 30 cases of non-puerperal osteomalacia, some of which were associated with hyper- and some with hypothyroidism. Basal metabolism is not mentioned.

Pause (Cristofoletti, 1911) produced bone changes resembling osteomalacia in pregnant rabbits by removing the thyroid, and recommended thyroid extract in the treatment of osteomalacia. Stettner (1931), on the other hand, reported marked decalcification of the bones of a child resulting from long-continued administration of thyroid extract, with clinical improvement when the extract was discontinued.

Kolodny (1924) found no evidence of healing forty-two days after a fracture in thyroidectomized dogs. Baetzner (1930) and Baumann (1931) reported that the administration of thyroid extract speeded up the healing of fractures in cases where callus formation was slow or incomplete.

Blood calcium studies in hyperthyroidism, as reported in the literature, have given conflicting results which are probably to be attributed to faulty chemical technique. The serum calcium was found by Leicher (1922) to be below normal in hyperthyroidism and after the administration of thyroid extract, by Herzfeld and Neuburger (1924) to be both above and below normal in 19 cases of hyperthyroidism, and by Waldorp and Trelles (1925) to be low in 26 individuals with the same disease.

Aub, Bauer, Heath and Ropes (1929) established the fact that the blood calcium

* From the Roentgen Ray Department of the Presbyterian Hospital and the Department of Medicine of the College of Physicians and Surgeons, Columbia University, New York. Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

and phosphorus are normal in hyperthyroidism. They showed, however, that this condition is associated with an increase in calcium excretion which is out of proportion to the elevation of the basal metabolism. Likewise the ingestion of thyroid extract by normal individuals caused an increased output of calcium. The mechanism of this increased elimination of calcium is unknown (Aub et al.; Albright, Bauer and Aub).

The effect of excessive thyroid secretion on the bones of young persons is ordinarily described in books on roentgenology as an acceleration of growth and of closure of epiphyses.

Aub et al., Plummer, and Dunlap and Moore, reported cases of hyperthyroidism in which decalcification of bones was shown on roentgen examination. It is probably present in many cases but becomes marked only when the disease is of long standing (Plummer). In mild cases it can be detected only by direct comparison with the same bone of a normal individual exposed on the same film at the same time (Aub et al.). It may involve all bones but when slight is most readily observed in the spongy portions; it may be so marked as to suggest malignant metastases (Dunlap and Moore). Osteomalacic changes should be looked for in the bones of adults with hyperthyroidism (Schittenhelm).

We have examined the roentgenograms of 110 cases of hyperthyroidism in an attempt to determine how frequently decalcification of the bones sufficient to be of diagnostic importance might be encountered in an unselected series. In 63 instances only chest films were available; in the remainder, portions of the spine, pelvis or extremities were at hand. It is obviously impossible to make anything like an accurate estimation of the calcium content of the bones as compared with the probable normal at any given age and to determine the presence of slight degrees of decalcification without some such procedure as recommended by Aub et al. Even without direct comparison with the normal, it is quite possible that more evidence of decalcification might have been disclosed by films of bones other than those available. It is also likely that other observers would disagree with our judgment in certain cases. It seemed worth while, however, to attempt a judgment based on experience, labeling the cases as showing no, slight, definite, or marked decalcification. Dunlap and Moore detected marked thyrotoxic decalcification on the chest films in one case.

Of the 110 cases, the available films showed what we considered to be not definitely abnormal bone density in 86 (78 per cent), slight decalcification in 12, definite in 9 and marked in 3.

The age of the patients ranged from sixteen to sixty-eight years; 28, or approximately 25 per cent, were fifty or over. Of the 24 cases showing bone density which we considered to be below normal, 17 were over fifty; the 3 in which the decalcification was marked were all over fifty.

The duration of the symptoms of thyrotoxicosis as recorded in the histories varied from two months to twenty-six years. It was more than two years in 22 and more than five years in 6. The duration of the disease in the 3 "marked" cases was five months, one year and two and one-half years (one of them had a basal metabolism of +95 per cent). In only 8 of the 24 cases showing some degree of decalcification was the duration of the symptoms more than two years.

In 9 unselected cases a direct comparison was made of the density of the bones of the hand with those of a normal of the same sex and approximately the same age taken with the same exposure on the same films as recommended by Aub et al. These patients were from twenty-two to fifty years old. The duration of the disease was from four months to four years; in 5 instances it was not over six months. Of the 9 cases thus compared, 5 showed evidence of definite and one of slight decalcification; the other 3 were normal.

The low incidence of decalcification in

the large series described above is probably incorrect but the study indicates that it is not sufficiently marked to be of differential diagnostic importance in the vast majority of cases. We have been unable to find a report of a case of thyrotoxicosis with decalcification of the bones in which a return to normal bone intensity followed relief of the hyperthyroidism.

Conclusion

Hyperthyroidism produces an abnormal elimination of calcium, the mechanism of which is not understood. It seems to be frequently associated with a decalcification of the bones demonstrable on the roentgenogram by suitable comparison with the normal, which is so slight as to be of little if any importance. In rare cases the decalcification of the bones may be extreme. Its appearance, however, is not characteristic of thyrotoxicosis.

II. Hypothyroidism.

The growth-limiting effect of lack of thyroid secretion in the young such as in cretinism or infantile myxedema is well known (Barker, Köhler, Engelbach and McMahon). We have found no mention of bone density in hypothyroidism (Barker, Köhler, Falta, Baetjer and Waters, Emerson, Käding) except by Janney who says, referring to cretins, "Often the bones are apparently normal roentgenologically (except for disturbances in development). . . . The long bone shafts may be the seat of osteoporotic and sclerotic changes, the marrow cavity is usually small." Myxedema in adults produces no demonstrable roentgen changes in bones (Schittenhelm).

Leicher states that the blood calcium is above normal in myxedema. Aub et al. found calcium excretion markedly diminished in hypothyroidism.

We have examined the available films of 51 cases labeled hypothyroidism or myxedema in the files of the Presbyterian Hospital, New York, ranging in age from seventeen to eighty years. Cases in which a polyglandular syndrome seemed to be present were discarded. The assortment of films was about the same as in the hyperthyroid cases. The difficulties of the estimation of bone densities have already been discussed.

Of the 51 cases, 37 showed none, 9 slight, 3 definite and 2 marked decalcification. The last two were aged sixty-six and eighty years; the 3 showing definite decalcification were aged fifty-four, fifty-seven and sixty-three years. Many over fifty and even over seventy showed bones of apparently normal density. We doubt, therefore, that the thyroid condition had anything to do with the density of the bones in these cases.

We also examined the films of 20 cases labeled infantile myxedema or cretinism, ranging in age from four months to twelve years. In all but one, the films included one or more extremities. In only one case, recorded as "hypothyroid dwarfism" was there definite decalcification. The long bones of all the cretins showed a widening of the cortex in relation to the width of the shaft as compared with non-cretins of the same chronological age. A circle of increased density around the margins of the carpal centers of ossification and thickening of the zones of preparatory calcification were occasionally noted. The well-known disturbance and delay in epiphyseal and ossification center development needs no comment.

Conclusion

In cretinism and infantile myxedema there is a widening of the cortex of the long bones without loss of calcium.

Hypothyroidism in adults is apparently associated with no greater incidence of decalcification of bones than that which might be encountered in any group of patients of the same age.

ADRENALS

Attention was first directed toward a possible relation between the adrenals and the bones by Bossi in 1907. He removed one adrenal gland in 3 sheep and found by histological examination of the bones that

osteomalacia developed. He treated osteomalacia by the injection of adrenalin on the theory that it would contract the blood vessels in the bone and relieve pain. The results were very satisfactory. This evidence indicated to him that osteomalacia is caused by an insufficiency of the adrenals. His case reports are interesting but his experimental work is unconvincing. Biedl, Cristofoletti, Solda, and Erdheim were unable to confirm Bossi's results following extirpation of the adrenals in animals (Scipiades).

Cristofoletti (1911) removed both adrenals from 60 rabbits and a number of white rats. Some of the animals lived longer than four weeks. None showed evidence of bone disease. Novak found no skeletal changes after adrenal extirpation (Kosdoba).

No bone changes resembling osteomalacia have been described in the literature at our disposal in either Addison's disease or virilism. Chabrol and Haguenau (1923) reported a necropsied case of osteomalacia of twenty-five years' duration with very large (30 gm.) adrenals. Erdheim found no adrenal disease at necropsy in cases of osteomalacia (Scipiades).

Bauer (1912) relieved the pain of osteomalacia by injections of adrenalin but did not consider the adrenals to be the cause of the disease. Assmann records the temporary relief of pain by the same medication in a similar case, later cured by castration. Varaldo attributed the favorable effect of adrenalin injections in this disease to a damage to the over-functioning ovaries (Scipiades). Bernard (1931) claims that he cured a case of osteomalacia by subcutaneous injections of adrenalin continued over a considerable period of time. Curschmann (1919) believed that the adrenals have nothing to do with the disease.

Cristofoletti states that adrenalin injections caused the calcium output to increase and cannot be recommended as a treatment for osteomalacia although in some cases they have a favorable effect on the symptoms. He thinks that the ovaries have a depressing effect on the chromaffin system especially in pregnancy and that osteomalacia is caused by an endocrine imbalance. Bauer (1921) remarks that injections of adrenalin caused an increased calcium output.

The removal of both adrenals in animals is followed by a slight rise in the serum calcium (Swingle, 1926), by a decided rise three to five hours after the operation (Taylor and Caven, 1927), by a rise simultaneous with or slightly in advance of symptoms of adrenal insufficiency (Rogoff and Stewart, 1928).

Of 3 cases of Addison's disease at the Presbyterian Hospital (Loeb) the serum calcium was normal in 2 and definitely increased in one, two days before death.

The injection of alcoholic extracts of suprarenal cortex, according to Mirvish and Bosman, temporarily lowered the blood calcium in the majority of 50 rabbits. They believe this hormone to be antagonistic to that of the parathyroids.

The conflicting opinions in the literature regarding the relation between the adrenals and osteomalacia, calcium metabolism and bone regeneration, and the effect of adrenalin injections are well summarized by Kosdoba (1932) and will not be further recapitulated here. Calcium metabolism is under so many and variegated influences that it is difficult to appraise the effect of any one. For example, in 3 normal young men, subjects for studies of normal electrolyte balances, Loeb found a shift to a negative calcium balance in the course of three to five weeks on a regimen which required the subjects to be in bed all the time except for four hours a day. The same results were obtained in 2 diabetics under the same regimen. It is evident that simple rest in bed is sufficient to throw a normal person into a negative calcium balance.

We have examined the available roentgenograms of 14 cases of Addison's disease, ranging from seventeen to seventy-four years of age. Three showed questionable slight decalcification and one a marked diminution in density of the bones of the

hands. These 4 patients were all over fifty years old.

Two cases of adrenal tumor, aged three years, showed in one instance slight and the other definite decalcification with a peculiar coarsening of trabeculation.

Conclusion

Although adrenal secretion either directly or indirectly influences calcium metabolism, and although the adrenals may be indirectly involved in a pluriglandular imbalance in certain cases of osteomalacia, the evidence does not seem to justify the assumption that decalcification of the bones results directly from adrenal disease or dysfunction.

ISLANDS OF LANGERHANS

Considerable evidence has been presented in the literature that a loss of calcium from the body takes place in diabetes. Von Noorden quotes Bocker as having demonstrated in 1853 an increased excretion of calcium in the urine of diabetic patients as compared with normal persons. Neubauer, and Toralbo later made similar observations. Von Noorden found that a diabetic patient excreted more calcium in both urine and feces than he took with his food.

Gerhardt and Schlesinger (1899) stated that the output of calcium in the urine is especially high in acidosis, runs parallel with the ammonia excretion and is reduced by the administration of alkali. Dengler found that the calcium loss could be stopped by giving calcium but not sodium (von Noorden). Sawyer, Baumann and Stevens (1918) disclosed a negative calcium balance in a child with marked acidosis and a normal balance in another with less acidosis. Von Noorden states that the calcium metabolism is the same in diabetics in the absence of acidosis as in normal persons. Kahn and Kahn (1916), however, found a negative calcium balance in 5 cases of mild diabetes without acidosis. Kahn and Hoffmann (1915) found a daily calcium loss in diabetes which was much reduced when the glycosuria stopped; the administration of calcium chloride changed the calcium balance from negative to positive. Wishnofsky (1927) concludes that a negative calcium balance has been established in diabetes.

Falta and Whitney (1908) found that pancreatectomy in dogs was followed by an immediate and rapid elimination of calcium. Meyer-Bisch (1927) demonstrated a decrease in blood calcium of 1.2 to 2.0 mg. per 100 c.c. in 12 of 16 pancreatectomized dogs. Kolodny (1924) reported a marked slowing up of callus formation in incompletely pancreatectomized dogs.

Opinions on the blood calcium level in diabetes and the effect of insulin on it differ. Harrop and Benedict (1924) showed the blood calcium to be normal in diabetics with severe acidosis and to be uneffected by the administration of insulin. Davies, Dickens and Dodds (1926) found the blood calcium increased in rabbits after the injection of insulin. Brougher (1927) reported an increase in blood calcium for two and a half hours after the injection of insulin. Kylin (1927) states that the blood calcium is higher than normal in diabetics and that the injection of insulin lowers it and causes an increased output of calcium in the urine.

These discrepancies may well be due to the difficulties inherent in the technique of calcium determinations. One must accept the work of those whom he knows to be accurate and careful chemists.

There is some evidence that decalcification of the bones may occur in diabetes. Ferrier refers to some work by Tessier (1876) and Charrin (1905) in which skeletal decalcification in animals was produced by giving lactic acid. Stettner (1931) states that acidosis may cause osteoporosis. Udaondo (1919) described a marked increase in the fragility of the bones in 2 diabetics who had the disease a long time. The fractures were very slow in healing. The injection of sugar into rabbits for from one to three months resulted in a softening and transparency of the bone

and spontaneous fractures occurred. This he attributed to hyperglycemia.

Morrison and Bogan (1927) found that bone atrophy occurs in a certain number of children who develop diabetes before the ninth year but not after that age. Narrowness of the shaft and thinness of the cortex were noted in the bones of children with long-standing diabetes.

A much emaciated boy of ten years of age, who came to the Presbyterian Hospital in 1922 with severe diabetes and acidosis, had marked decalcification of the bones of a character such as to suggest osteomalacia. There was also marked irregularity and delay in the development of the centers of ossification in the epiphyses and carpal bones. He was among the first patients to receive insulin and improved greatly. Four years later the bones of the lower extremities appeared normally dense on the roentgenograms. Films of the bones of 10 other diabetic children showed definite decalcification in only 2 and these were undernourished.

Examination of the available films of 60 adult diabetics disclosed definite decalcification in 9 and slight in 6, of whom 4 were over seventy years of age, 6 over sixty, 3 over fifty and 2 others forty-nine and thirty-eight. Many of these patients had one or more complicating conditions such as arthritis, arteriosclerosis, cardiac disease, etc., which made it difficult to attribute the bone condition to diabetes. Of the 15 showing diminished bone density, acidosis was present in only one instance. One youth of fourteen had diabetes of two years' duration with considerable acidosis and definite decalcification.

Conclusion

Calcium metabolism is intimately linked up with carbohydrate metabolism. The available evidence indicates that a calcium loss may take place in diabetes, especially with acidosis, although not in every case. In children the disease may be associated with a decrease in bone density on the roentgenogram, which in one case was so marked as to suggest osteomalacia. The question may be raised as to how much of this is of endocrine and how much of nutritional origin. Roentgen evidence of definite important skeletal decalcification in diabetic adults which can be attributed directly to the disease is lacking.

SUMMARY

The evidence at hand indicates that skeletal decalcification of a degree sufficient to be of differential diagnostic importance on the roentgenogram and attributable to the endocrine disturbance may be encountered in hyperthyroidism but not in hypothyroidism, in disease of the adrenals nor in adult diabetics. In diabetic children decalcification of the bones is occasionally found, for which acidosis or malnutrition or both together are probably responsible.

REFERENCES

1. Albright, F., Bauer, W., and Aub, J. C. Studies of calcium and phosphorus metabolism; influence of thyroid gland and parathyroid hormone upon total acid-base metabolism. *J. Clin. Investigation*, 1931, *10*, 187–219.
2. Assmann, H. Die klinische Röntgendiagnostik der inneren Erkrankungen. Fourth edition. F. W. C. Vogel, Leipzig, 1929, p. 969.
3. Aub, J. C., Bauer, W., Heath, C., and Ropes, M. Studies of calcium and phosphorus metabolism. III. The effects of the thyroid hormone and thyroid disease. *J. Clin. Investigation*, 1929, *7*, 97–137.
4. Baetjer, F. H., and Waters, C. A. Injuries and Diseases of the Bones and Joints. P. B. Hoeber, New York, 1921.
5. Baetzner, W. Vorläufige Mitteilung. [Schilddrüsenpräparate und Knochenbildung.] *Zentralbl. f. Chir.*, 1930, *57*, 2906.
6. Barker, L. F. Endocrinology and Metabolism. Appleton and Co., New York, 1922.
7. Barker, L. F. The classical endocrine syndromes. *N. York M. J.*, 1921, *113*, 353. Abs. in Tice, *Internat. Med. Digest*, 1921, *2*, 757.
8. Bauer, J. Kalkstoffwechsel und innere Sekretion. *Wien. klin. Wchnschr.*, 1921, *34*, 314.
9. Bauer, J. Zur Klinik der Tetanie und Osteomalazie. Ein Beitrag zur Pathogenese der kal-

zipriven Osteopathien. *Wien. klin. Wchschr.*, 1912, *25*, 1780–1787.
10. Baumann, E. Die Anregung der Knochenneubildung durch Schilddrüsenpräparate. *Zentralbl. f. Chir.*, 1931, *58*, 655–657.
11. Berman, Louis. The endocrine treatment of Paget's disease. *Endocrinology*, 1932, *16*, 109–119.
12. Bernard, L. Osteomalacie. *Tr. méd. Brouardel*, 1912, *39*. Les ostéopathies myélogènes. *Rev. de méd.*, 1909. Also: *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1931, *55*, 1213.
13. Bernhardt, H. Ein Beitrag zur nichtpuerperalen Osteomalazie. *Deutsche med. Wchnschr.*, 1927, *53*, 1082.
14. Biedl. Quoted by Scipiades, ref. 59.
15. Bocker. Quoted by von Noorden, ref. 68.
16. Bossi, M. L. Die Nebennierren und die Osteomalacie. *Arch. f. Gynäk.*, 1907, *83*, 505.
17. Brougher, John C. Blood calcium as affected by insulin. *Am. J. Physiol.*, 1927, *80*, 411–415.
18. Chabrol, E., and Haguenau. Un cas d'ostéomalacie masculine; étude des glandes à sécrétion interne. *Bull. et mém. Soc. méd. d. hôp. de Par.*, 1923, *47*, 973–977.
19. Charrin. Quoted by Ferrier, ref. 30.
20. Cristofoletti, R. Zur Pathogenese der Osteomalazie. *Gynaek. Rundschau*, 1911, *5*, 113; 169.
21. Curschmann, H. Ueber den mono- und pluriglandulären Symptomenkomplex der nichtpuerperalen Osteomalacie. *Deutsches Arch. f. klin. Med.*, 1919, *129*, 93.
22. Davies, D. T., Dickens, F., and Dodds, E. C. Observations on the preparation, properties and source of the parathyroid hormone. *Biochem. J.*, 1926, *20*, 695–702.
23. Dengler. Quoted by von Noorden, ref. 68.
24. Dunlap, H. F., and Moore, A. B. Osteoporosis secondary to hyperthyroidism. *Med. Clin. N. Am.*, 1929, *12*, 1511–1519.
25. Emerson, C. P. Abt's Pediatrics. W. B. Saunders Co., Philadelphia, 1923–1926. Congenital and Infantile Myxedema. Vol. 4, p. 805; Cretinism. Vol. 4, p. 816.
26. Engelbach, Wm., and McMahon, Alphonse. Osseous development in endocrine disorders. *Radiology*, 1924, *2*, 378–410.
27. Erdheim. Quoted by Scipiades, ref. 59.
28. Falta, Wilhelm. Endocrine Diseases. Edited and translated by Sir Archibald E. Garrod. P. Blakiston's Son and Co. Third edition. Philadelphia, 1923.
29. Falta, W., and Whitney, J. L. Zur Kenntnis des Eiweiss- und Mineralsstoffwechsels pankreasdiabetischer Hunde. *Beitr. z. chem. Phys. u. Path.*, 1908, *11*, 224–228. Quoted by Wishnofsky, ref. 70.
30. Ferrier, P. Malades physiologiques. *Bull. Acad. de méd.*, 1928, *99*, 283–289.
31. Foerster, A. Zur Frage der nichtpuerperalen Osteomalazie. *Wurzb. Abhandl. a. d. Gesamtgeb. d. Med.*, 1925, *22*, 243–253.
32. Gerhardt, D., and Schlesinger, W. Ueber die Kalk- und Magnesiumausscheidung beim Diag. Mell. und ihre Beziehung zur Ausscheidung abnormer Säueren (Acidose). *Arch. f. exper. Path. u. Pharmakol.*, 1899, *42*, 83.
33. Goldner, J. Thyroid function during consolidation of fractures. *Compt. rend. Soc. de biol.*, 1925, *92*, 725–727. Abs. *J. Am. M. Ass.*, 1925, *84*, 1532.
34. Harrop, G. A. Jr., and Benedict, E. M. The participation of inorganic substances in carbohydrate metabolism. *J. Biol. Chem.*, 1924, *59*, 683–697.
35. Herzfeld, E., and Neuburger, J. Hyperthyroidism and blood calcium. *Deutsche med. Wchnschr.*, 1924, *50*, 1324–1325. Abs. *J. Am. M. Ass.*, 1924, *83*, 1465.
36. Hoennicke, E. Zur Theorie der Osteomalacie; zugleich zur Lehre von den Krankheiten der Schilddrüse. *Berl. klin. Wchnschr.*, 1904, *41*, 1154.
37. Janney, N. W. Endocrinology and Metabolism. Edited by L. F. Barker. Appleton and Co., New York, 1922, Vol. I, p. 391.
38. Käding, K. Endokrine Störungen und Röntgendiagnostik. *München. med. Wchnschr.*, 1927, *74*, 747–751.
39. Kahn, M., and Hoffmann, J. Calcium metabolism in normal and diabetic individuals. *Biochem. Bull.*, 1915, *4*, 213.
40. Kahn, M., and Kahn, M. H. Lime deficiency of diabetes mellitus. *Arch. Int. Med.*, 1916, *18*, 212.
41. Köhler, A. Röntgenology. English translation by Arthur Turnbull. Wm. Wood and Co., New York, 1927.
42. Kolodny, A. Endocrine disturbances and nonunion of fractures; experimental study. *Surg., Gynec. & Obst.*, 1924, *38*, 793–797.
43. Köppen. Ueber Knochenerkrankungen bei Morbus Basedowii. *Neurol. Centralbl.*, 1892, *11*, 219.
44. Kosdoba, A. S. Experimentelle Untersuchungen über die Heilung von Knochenbrüchen bei Nebennierenhyperfunktion. *Arch. f. klin. Chir.*, 1932, *169*, 96–106.
45. Kylin, E. Ueber den Kalkumsatz bei Diabetes mellitus. *Acta med. Scandinav.*, 1927, *66*, 197–206.
46. Latzko. *Jahrb. d. Psychiat. u. Neurol.*, 1901, *20*, 410.
47. Leicher, H. Action of endocrines on serum calcium. *Deutsches Arch. f. klin. Med.*, 1922, *141*, 85–116. Abs. *J. Am. M. Ass.*, 1923, *80*, 882.
48. Loeb, Robert. F. Personal communication.
49. Meyer-Bisch, R. Mineral- und Wasserstoff-

wechsel bei Diabetes mellitus. *Ergebn. d. inn. Med. u. Kinderh.*, 1927, *32*, 267–312.

50. MIRVISH, L., and BOSMAN, L. P. The effect of extracts of suprarenal cortex on the blood calcium. *Brit. J. Exper. Biol.*, 1929, *6*, 350.
51. MORRISON, L. B., and BOGAN, I. K. Bone development in diabetic children; a roentgen study. *Am. J. M. Sc.*, 1927, *174*, 313–319.
52. NEUBAUER. Quoted by von Noorden, ref. 68.
53. NOVAK. Quoted by Kosdoba, ref. 44.
54. PAUSE. Quoted by Cristofoletti, ref. 20.
55. PLUMMER, W. A. Cases showing osteoporosis due to decalcification in exophthalmic goiter. *Proc. Staff. Meet. Mayo Clinic*, 1928, *3*, 119–121.
56. ROGOFF, J. M., and STEWART, G. N. Studies on adrenal insufficiency. VII. Further blood studies (cholesterol and calcium) in control adrenalectomised dogs. *Am. J. Physiol.*, 1928, *86*, 25–31.
57. SAWYER, M., BAUMANN, L., and STEVENS, F. A. Studies of acid production. II. The mineral loss during acidosis. *J. Biol. Chem.*, 1918, *33*, 103.
58. SCHITTENHELM, A. Lehrbuch der Röntgendiagnostik. Springer, Berlin, 1924, p. 1170.
59. SCIPIADES, E. Ueber Osteomalacie. *Ztschr. f. Geburtsh. u. Gynäk.*, 1919, *81*, 156–226.
60. STETTNER, E. Ossificationstudien am Handskelet des Kindes. IV. Pathologisches Osteoporoseformen. Hyperthyreoide Osteoporose. Die jahreszeitliche Schwankung der Osteoporose. Der "Winterschaden." Chronische Osteoporosezustande. *Ztschr. f. Kinderh.*, 1931, *52*, 14–23.
61. SWINGLE, W. W. Studies on the functional significance of the suprarenal cortex. I. Blood changes following bilateral epinephrectomy in cats. *Am. J. Physiol.*, 1927, *79*, 666–678.
62. TAYLOR, N. B., and CAVEN, W. R. Observations upon the serum calcium after adrenalectomy. *Am. J. Physiol.*, 1927, *81*, 511.
63. TESSIER, J. Quoted by Ferrier, ref. 30.
64. TOLOT, G., and SARVONAT, F. Ostéomalacie et goitre exophtalmique. *Rev. de méd.*, 1906, *26*, 445–455.
65. TORALBO. Quoted by von Noorden, ref. 68.
66. VARALDO. Quoted by Scipiades, ref. 59.
67. VON JAKSCH, R., and ROTKY, H. Ueber eigenartige Knochenveränderungen in Verlaufe des Morbus Basedowii. *Fortschr. a. d. Geb. d. Röntgenstrahlen*, 1908–1909, *13*, 1–21.
68. VON NOORDEN, C. Metabolism and Practical Medicine. W. T. Keener and Co., Chicago, 1907, Vol. III, p. 600.
69. WALDORP, C. P., and TRELLES, R. A. Calcémie et glycémie dans les maladies de la thyroïd avec augmentation du métabolism basal. *Rev. Soc. argent. de biol.*, 1925, *1*, 762–773.
70. WISHNOFSKY, M. Studies in calcium and carbohydrate metabolism; calcium and glucose tolerance in diabetes mellitus. *J. Lab. & Clin. Med.*, 1927, *13*, 133–138.
71. UDAONDO, C. B. Bone complications of diabetes. *Rev. de la Asoc. méd. argent.*, 1919, *30*, 285. Abs. *J. Am. M. Ass.*, 1919, *73*, 1733.

Vol. XXX, No. 5

SCHÜLLER-CHRISTIAN'S DISEASE*

By RUSSELL S. ROWLAND, M.D.
DETROIT, MICHIGAN

SCHÜLLER-CHRISTIAN'S disease or Christian's syndrome of defects in membranous bones, exophthalmos and diabetes insipidus, a special form of essential xanthomatosis has attracted considerable attention. There are now records of over 60 cases which closely conform to the syndrome. Recently general reviews have been made by Chiari,[1] Henschen,[2] Moreau,[3] Pincherle,[4] and in my presentation[5] last year, in textbook form, of lipid metabolism disturbances.

FIG. 1. Patient of Schüller's, aged four; onset at the age of two; exophthalmos, diabetes insipidus, bone defects.

FIG. 2. Patient of Thompson, Keegan and Dunn's, boy aged nine; onset at the age of seven and a half; exophthalmos, diabetes insipidus emaciation; extensive skull defects; "old man" appearance due to destructive bone changes in the maxillae.

This disease is of interest to the roentgenologist because of the importance of the roentgen ray in diagnosis and treatment. I believe you are familiar with the splendid work of Dr. Sosman on the roentgen treatment of this affection. As it is a relatively new disease, few comparative roentgenologic studies have been made and there is still much to learn from the roentgen examinations of the bones as to the nature of the change in the skeletal system.

Although the etiology is in doubt, the nature of the disease seems fairly well established and may be suggestive in determining the approach to the pathogenesis of other bone diseases. I am glad to have an opportunity to discuss some phases of the subject in this symposium on malacic bone affections.

Schüller-Christian's disease is a rare, probably familial, constitutional disorder of metabolism in which a deposition of lipid mixtures, particularly cholesterol and its ester, takes place leading to a characteristic hyperplastic reaction in the reticulo-endothelial or the histiocytic apparatus. The

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

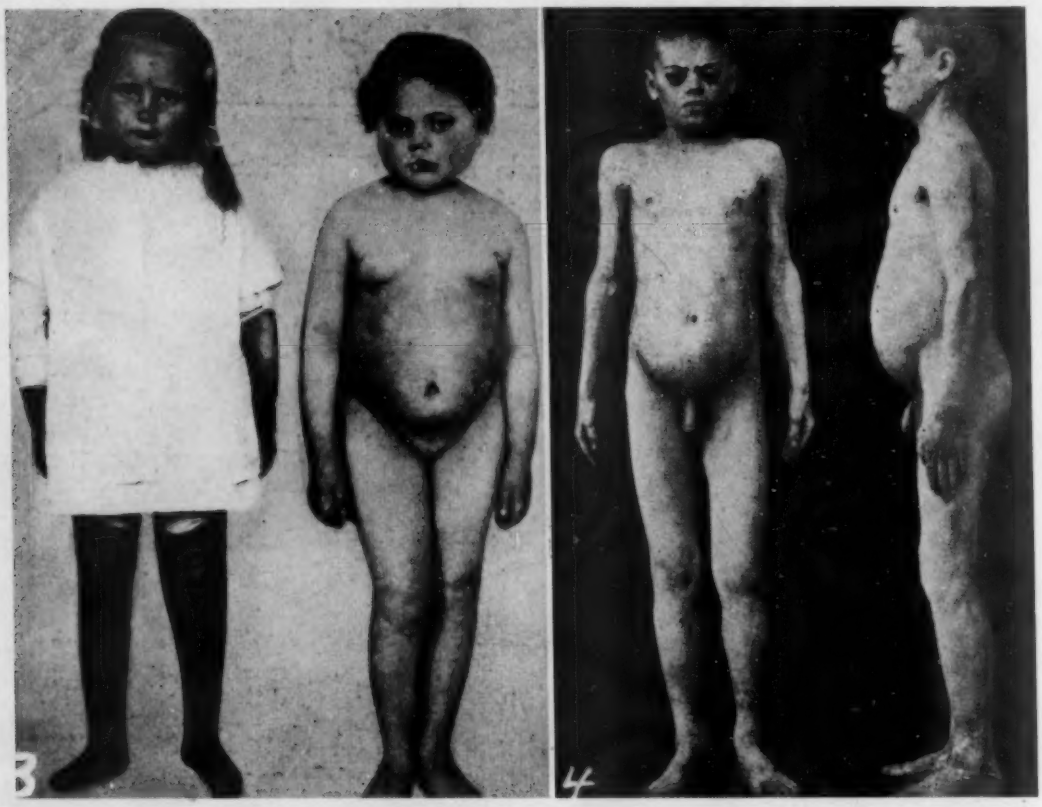


Fig. 3. Patient of Kyrklund's, girl aged twelve; onset with thirst and polyuria at the age of four; retarded growth and mental development. Suddenly became fat at the age of seven, developing the clinical picture of dystrophia adiposogenitalis. At her side a normal child of five.

Fig. 4. Patient of Alberti's, boy aged twenty-one; hypogenitalism and subnormal mentally. Mentality of a boy of thirteen.

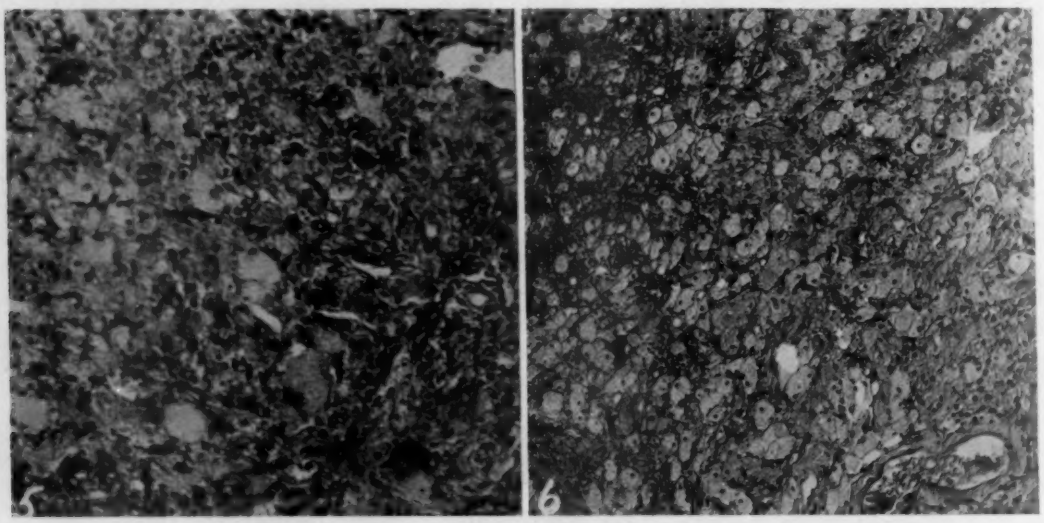


Fig. 5. Dural plaque, many large foam cells, round cells, eosinophile cells, fibrosis, clear spaces, cholesterol clefts.

Fig. 6. Section from lower end of right femur; many foam cells, round cell infiltration.

common pathologic change is a granuloma-like accumulation arising from connective tissue in many parts of the body. Usually three cardinal symptoms—bone defects, exophthalmos and diabetes insipidus—are present but it should be understood that no one of these is essential and that there are others which sometimes appear of equal importance.

The most often observed form of the disease occurs in early childhood but there are also rare adolescent and adult types. As Schüller-Christian's disease is a constitutional affection, symptomatology and pathology vary with different stages of development and with the age period of the patient. In this discussion, I shall draw attention to these variations in a description of the symptomatology and pathology, giving my own interpretation of the changes in the skeletal system.

In the early childhood form of Schüller-Christian's disease, the patient gives a history of good health up to the time of onset. During the second, third or fourth year following one of the common childhood affections (measles, mumps, scarlet fever or pertussis) convalescence is prolonged, there is increased irritability, excessive thirst, exophthalmos, sore mouth with loose teeth or vague pains referred to various parts of the body. Sometimes there is a limp or abnormal posture. On examination bone defects are found. The disease progresses irregularly. The bone defects increase. There may be periods of unexplained fever, the skin becomes pale, dry and scaly, or a fine papular eruption appears over various parts of the body. Sometimes the spleen, liver and lymph nodes become moderately enlarged. There is an arrest of growth and emaciation. Respiratory symptoms appear; the child becomes cyanotic and dyspneic or very pale and anemic; the heart dilates slightly. Frequently death occurs in from two to four years as a result of respiratory and cardiac complications or severe anemia.

In the occasional more protracted adolescent forms of the disease there are at first very few symptoms. Growth, however, is retarded. The bone defects increase slowly although during remissions they may become smaller and even disappear. The exophthalmos, polyuria and polydipsia sometimes lessen or entirely subside for a period. Occasionally around the seventh or eighth year, the child suddenly grows fat, assuming the appearance of a dystrophia adiposo-

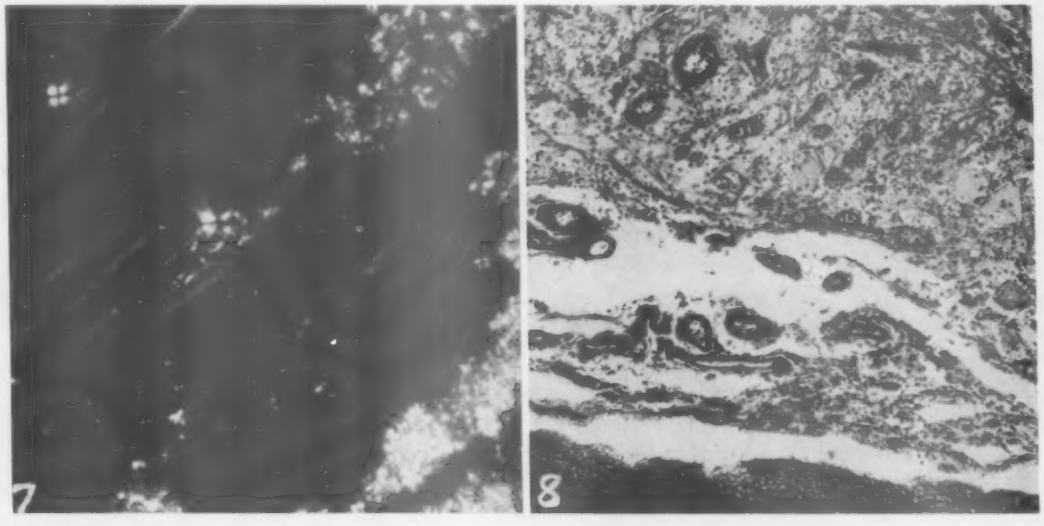


Fig. 7. Dural plaque showing anisotropic fat (cholesterol ester) as it appears in the polarizing microscope.
Fig. 8. Tuber cinereum section showing many foam cells. Characteristic xanthomatotic granuloma-like tissue.

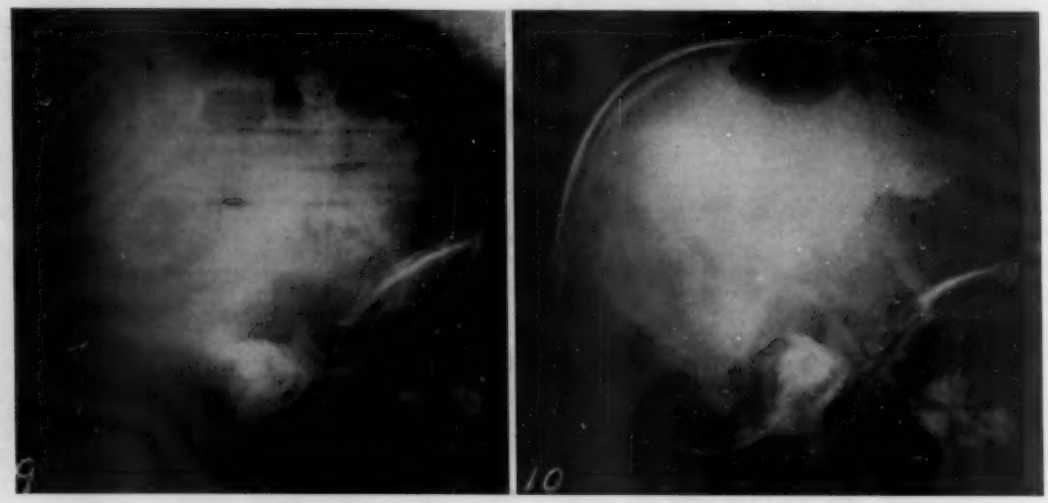


Fig. 9. Showing skull defects in the calvarium and at the base involving the sella turcica.
Fig. 10. Same patient six months later, showing extensive increase in the destructive process.

genitalis, with signs of mental retardation. Patients with this protracted form live into the second and third decade.

In the still more protracted and rare cases or adult form of the affection, a true polyglandular syndrome may develop. In one case, the hypophyseal cachexia of Simmonds was observed and in others acromegaly with lipemia and glycosuria. In this type, the bone changes vary considerably from those observed in the infantile and adolescent forms.

The remarkable pathology which accounts for most of these symptoms appears first as masses of foam cells, or histiocytes loaded with fat, in the tissues surrounding the small blood vessels; then in the form of granuloma-like accumulations arising from dense connective tissue or as a more diffuse process in many tissues and organs, and finally as a marked fibrosis and foreign body giant cell reaction. These changes intermingle and are only determined by careful study. In the bone pathology they are still further confused by the fact that one cannot entirely separate lesions of the dura and periosteum from bone marrow lesions and by a constant tendency towards healing which confuses the pathologic picture.

The infiltration of foam cells in the bone marrow is sometimes circumscribed, sometimes diffuse. In many places a small round or eosinophile cell infiltration is well marked, and hemorrhagic areas intermingled with necrosis are frequent. As a consequence of the massive growth of foam cells in the marrow spaces, the bone trabeculae gradually atrophy and degenerate so that the normal bone disappears. In an advanced stage the cortex of the bone is replaced by new-formed spongiosa with here and there osteoid and cartilage-like tissue. In some areas the new tissue appears as a fine spongy layer below the original cortex and in other places, where bone tissue is completely absent, the peripheral fibrous layer reaches directly to the periosteum. The periosteum is usually unchanged but in older adult forms of the disease there may be a building of new bone which generally develops inside the periosteum both in the calvarium and long bones. In the healing process large areas of fibrosis and finally dense osteoid tissue are found.

The bone resorption resembles in many respects that seen in osteomalacia, that is, a demineralization atrophy although it is really a destructive bone process or a pressure atrophy. At autopsy the bone surrounding the defects is frequently found to be soft. In a case which I recently observed,

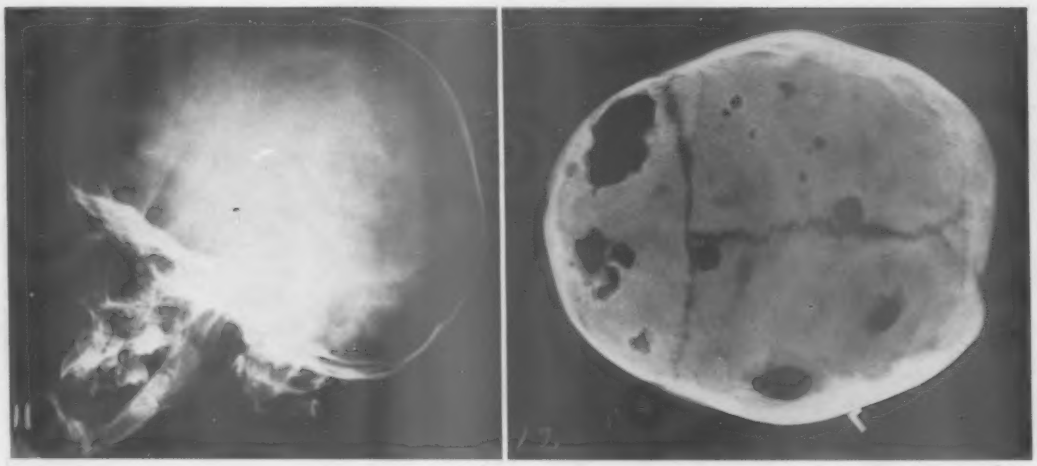


Fig. 11. Same patient as in Figure 9 one year later—almost complete disappearance of bone defects, with formation of dense bone at the base, osteosclerotic healing process.

Fig. 12. Photograph of the calvarium showing characteristic moth-eaten appearance.

the calvarium was soft and pliable and the whole base of the skull cut like cheese. Histologically the bone lesions frequently give a superficial impression of osteitis fibrosa or occasionally, in the more advanced adult form of the disease, of an osteitis deformans.

Changes in the skull are of first importance in this disease. Roentgen examination sometimes reveals extensive bone destruction or defects in the calvarium, and at the base of the skull involving the sella turcica, sinuses, orbit, mastoid and facial bones. One or both tables of the skull may be affected. The destructive change has been compared to the moth-eaten holes in a piece of flannel or, when extensive, to the gulfs and lakes on a map and the roentgen picture has been aptly described as "geographic." The larger bone defects occur in the places where bone marrow and dura or periosteum are affected.

The membranous and flat bones are most often involved but changes may occur in any part of the skeleton. Roentgen examination reveals similar, though less extensive, changes in the superior and inferior maxillae, flat bones of the pelvis, scapulae, ribs, vertebrae and the long and short bones. The defects in these bones have the same irregular moth-eaten appearance and sharply defined borders. Occasionally, when there is a cyst formation, the borders are less irregular and the defects are round or oval with less sharply defined edges. In an advanced stage of the disease, the edges are sometimes blurred, indicating an attempt at repair. New bone formation can even fill in large defects. The surrounding bone appears to be normal in the roentgenogram as do the bones in other parts of the skeleton. Bone thickening is rare in the acute form of the disease but occurs sometimes in the adult form, usually developing inside the periosteum.

A number of important symptoms result from the bone destruction. Loose teeth frequently occur. The gums become swollen, spongy, and tender, separating from the teeth which, although normal, loosen and fall out. In several cases a viscid yellow discharge from the middle ear occurred and persisted so that eventually a mastoid operation was performed. In healing, the infiltration in the mastoid region may lead to a deposit of dense bone and deafness. The antrums and nasal sinuses are sometimes affected in a similar manner and the marked destruction about the orbits may be a factor in the exophthalmos. Observations indicate, however, that the protrusion of the eyes is the result of the accumulation of

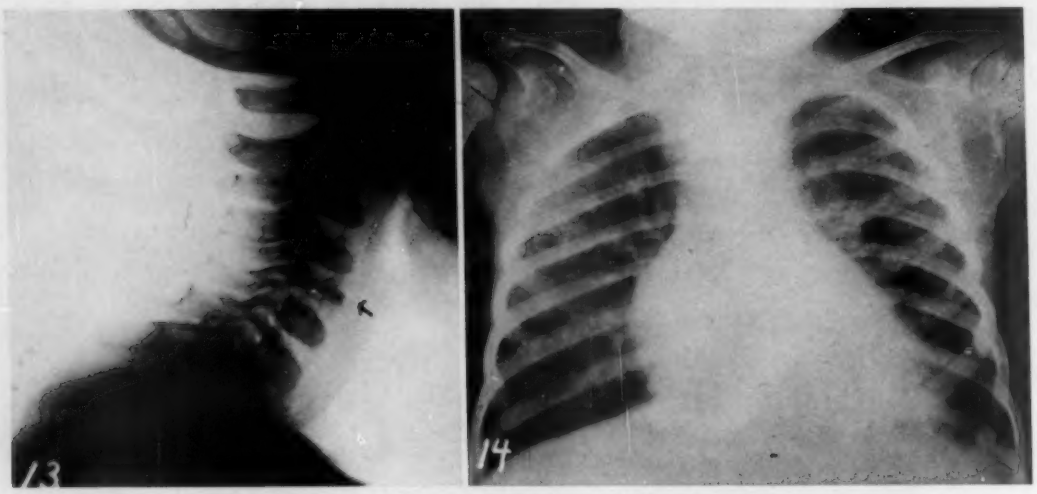


Fig. 13. Compression fracture of vertebral body. Patient had torticollis.
Fig. 14. Osteoporotic bone changes in the scapulae and ribs.

lipid granuloma in the orbits. It has been suggested that the retardation in growth may be due partly to lipidosis in the long bones (Henschen). In a few cases in connection with the bone destruction there has been a spontaneous fracture. When the vertebrae are involved, there is sometimes a compression fracture of the vertebral body and gibbus or torticollis. The intervertebral discs are never affected. There may be considerable deformity when the pelvic bones are involved. In a recent case of Moreau's there was expansion in the mid-diaphysis of the femur. It is of interest

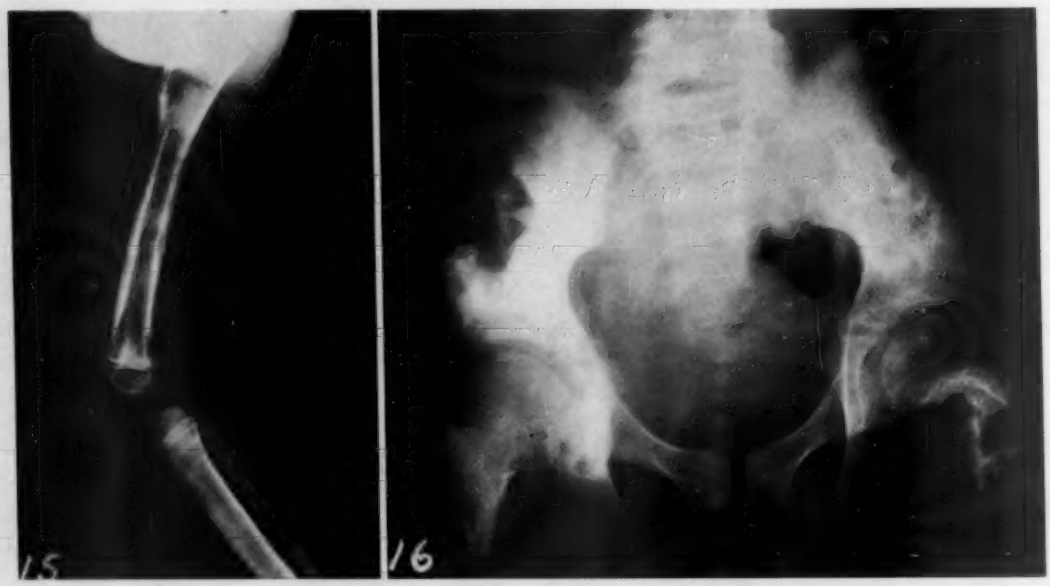


Fig. 15. Irregular defects of humerus and ribs with dense bony tissue layer inside the periosteum. Changes in many other parts of the skeleton.
Fig. 16. Extensive bone defects in the pelvic bones and femur showing the same change as in the skull.

that when there has been involvement of the pituitary gland, destructive changes in the sella and roentgen evidences of tumor have been found in less than one-third of the cases studied.

While the bone defects are the most striking symptom, the endocrine manifestations that may develop in the course of this affection are an interesting clinical feature. The characteristic pathologic change has been found in all the glands of internal secretion, in the thymus, testicles, suprarenals, pancreas, pineal, thyroid and parathyroids, and especially in the pituitary gland. All the cases that have been examined histologically show this change in varying degree.

The symptoms usually ascribed to endocrine factors in Schüller-Christian's disease are diabetes insipidus, growth disturbances, both somatic and sexual, and retardation of intellectual development. Diabetes insipidus is a cardinal symptom occurring in a large proportion of the cases. Associated with it, lipidosis occurs extensively in the hypophysis, tuber cinereum, and surrounding region at the base of the brain. It also has been observed, in several instances, that the pituitary was pushed up out of the sella by the new formation. Growth arrest has been most evident in cases in which the disease developed in early childhood but it occurs in adolescent cases along with hypogenitalism. In such cases there may be a rapid development of obesity and change in the hair growth. In the rare adult form there has been extreme emaciation and pigmentation suggesting Addison's disease or an increased growth in the facial bones, hands and feet, along with an atypical form of diabetes mellitus and lipemia. The patient with Simmonds' syndrome had a fibrosed anterior pituitary and those showing acromegalic symptoms had lipidosis in the pituitary, surrounding region at the base of the brain and other endocrine glands, which seems to indicate that the endocrine disturbance is the result of the lipidosis.

All this is of considerable interest because the changes in the bones have so frequently been regarded as related to endocrine influence. The diabetes insipidus, retarded growth and hypogenitalism as well as the rare Simmonds syndrome and acromegaly can be ascribed to the endocrine factor as well as the bone growth changes which occur late in the acromegalic cases, and there may be other endocrine influences affecting the bones in the later stages of this disease. But there seems to be no real evidence that the bone defects result from such a cause. They seem rather to be the outcome of the general pathologic change brought about by the excessive deposits of lipids in the tissues, and their variations in the late form of the disease are caused perhaps by the different stages of the healing process.

Our knowledge of the metabolism and chemistry of this affection is quite incomplete. The fact that we find large amounts of lipid deposited in the tissues is the main evidence for regarding Schüller-Christian's disease as a lipid metabolic disturbance. It is thought that in health there is a certain definite quantitative equilibrium or relationship among the fat-like substances in the body. If their balance is disturbed and any of the elements are in excess or diminished, the normal relationship is upset, one or more of the lipid constituents are deposited in the tissues, and a pathologic change results. It has been suggested that this disturbed equilibrium is in some way related to a disturbed liver function. Very few investigations have been made concerning the inorganic metabolism in this disease. The calcium values are normal or low, a fact which is interesting in an affection so extensively involving the skeleton.

There are many problems which need investigation in this constitutional disease. If some of my conclusions are still hypothetical I trust I have given a correlated picture of symptoms, pathology and endocrinologic features which may be helpful in a further roentgenologic study of this and other bone diseases.

REFERENCES

1. Chiari, H. Die generalisierte Xanthomatose vom Typus Schüller-Christian. *Ergebn. d. allg. Path. u. path. Anat.*, 1931, *24*, 396–450.
2. Henschen, F. Ueber Christians Syndrom und dessen Beziehungen zur allgemeinen Xanthomatose. *Acta paediat.* (*suppl. 6*), 1931, *12*, 1–93.
3. Moreau, J. La dysostose hypophysaire. *Arch. franco-belges de chir.*, 1930, *32*, 697; 865; 961. Monograph, 1931.
4. Pincherle, M. La syndrome di Hand-Schüller-Christian. *Arch. ital. di pediat. e puericul.*, 1932, *1*, 1–62.
5. Rowland, R. S. Anomalies of Lipid Metabolism. Oxford Medicine, Oxford University Press, New York and London, 1932. Vol. IV, pp. 214 (3)-(214 (109). (Literature.)

DISCUSSION

Dr. P. F. Morse, Detroit, Mich. I think there are only one or two things of any importance that concerned my department in this condition. This disease of Schüller-Christian is one of lipoid metabolism, characterized by a peculiar type of lipoidal granulation tissue. This material when you see it at post mortem occurs in yellow, inflammatory gumma-like masses. The whole base of the skull will be invaded by a peculiar yellow rubbery substance which has grown on and through the base of the skull, invaded the orbit, deformed structures at the base of the skull or whatever mechanical derangements may have resulted purely by accident from the growth of this gummatous, inflammatory tissue. I have always been impressed by the interesting fact that the oldest lesion in the body of these children is in the lungs. They have a diffuse pulmonary fibrosis, a chronic fibrous pneumonitis as the oldest lesion in the body. That is interesting in view of the fact that some of the French workers have claimed and others denied that the lung is the organ for elimination of cholesterol in the body, and that these cases are primarily hypercholesterinemia, resulting in an irritation strain on the lung which results in the fibrosis.

The bone lesions in this disease are not primary at all. They are not connected with calcium or metabolism. They do not belong to the primary malacic group as do osteitis fibrosa cystica and osteomalacia, but you have bone defects in Schüller-Christian's disease for the same reason that you have bone defects in aneurysm; that is, from pressure on the bony structures. This yellow, inflamed, gumma-like tissue is particularly erosive to bone and bone destructive, and wherever it grows the bone dissolves away. That is why there isn't a high blood calcium and an increased excretion in the urine because it isn't primarily a calcium disturbance. You never find a bone defect in Schüller-Christian's disease unless there is the yellow lipomatous tissue to make the defect.

Vol. XXX, No. 5

ERYTHROBLASTIC ANEMIA*

(COOLEY'S SYNDROME)

By F. F. BORZELL, M.D.
PHILADELPHIA, PENNSYLVANIA

A REVIEW of the literature upon the subject of congenital anemias is hardly necessary, especially since it has been so thoroughly covered by Baty, Blackfan and Diamond[1]. They reported 20 cases in addition to a review of 26 cases previously reported by various authors. They found no material improvement resulting from splenectomy except in the cases reported by Hitzrot. Concerning therapeutic application of roentgen rays, they consider that its use has been insufficient to judge accurately. Vogt and Diamond state that no form of therapy has been of any avail.

Cooley and his coworkers, who in 1927 first described the syndrome they called erythroblastic anemia, expressed the belief that splenectomy in addition to relieving the child of the burden of the enormous spleen may retard the progress of the disease.

The 3 cases here reported were submitted to roentgen therapy, one child on the service of Dr. Ralph S. Bromer and two on my service. The older patient (Figs. 1, 2, and 3)

FIG. 1. Case 1. Diagnosis, erythroblastic anemia. Note beginning striation in calvarium; trabeculation of facial bones.

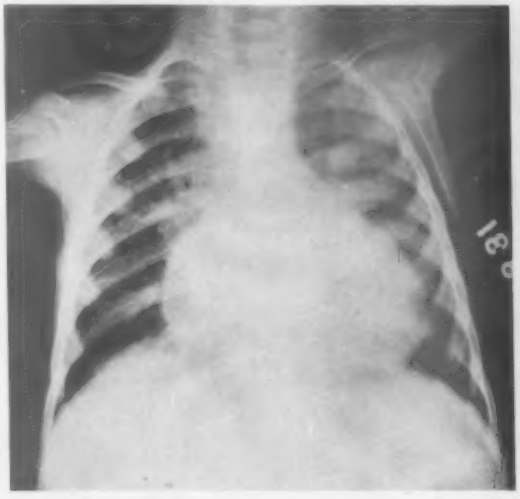


FIG. 2. Case 1. Roentgenogram showing bronchopneumonia, pulmonary exudate; trabeculation of clavicles and scapulae, and globular heart.

on my service, who was desperately ill when treatment was instituted, failed to respond in any way. On the contrary, the child became rapidly worse and died soon after from pneumonia. A post-mortem examination was made. The autopsy findings are given with the report of the case.

The younger child (Figs. 4 and 5), a sister, was not as far advanced a case as her sister. She appears to have improved following therapeutic application of roentgen rays. The spleen was reduced to normal size, the weight increased and appetite improved. The bone changes have apparently not progressed; in fact, there seems to be

[1] Baty, J. M., Blackfan, K. D., and Diamond, L. K. Blood studies in infants and in children; erythroblastic anemia. *Am. J. Dis. Child.*, 1932, *43*, 667–704.

* Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

FIG. 3. Case I. Note expansion of shafts and thin cortex, irregular trabeculation, and slight transverse striation.

some improvement. The blood picture, however, does not appear so hopeful. Hemoglobin has dropped to 25 per cent; leucocytes have remained about stationary. In January they numbered 14,500. The last examination two months ago showed 7,100. Erythrocytes have ranged from 1,970,000 to 1,590,000 in that time. There was some decrease in the number of erythroblasts and immature cells. Strangely enough, few normoblasts were reported but I doubt the accuracy of the differential count. My reasons for this are based on the absence of an accredited pathologist during this period and the fact that the first blood counts were checked by other laboratories, at which time the nucleated red cells numbered several hundred per 1000 counted. The high percentage of lymphocytes sometimes counted suggested the possibility of error in recognition of erythroblasts.

It is quite possible that the apparent improvement following irradiation may be a period of remission but I have found no instances recorded where the spleen was actually reduced in size and where clinical im-

FIG. 4. Case II. Diagnosis, erythroblastic anemia. First examination. Note the prominent trabeculation of the bones of the pelvis and long bones; medullary rarefaction and thin cortex of long bones.

provement was noted following any form of treatment, other than splenectomy, and then, as pointed out by Cooley, it was only temporary. We are disposed to consider that the results obtained were due to the institution of treatment in an early stage. Nevertheless, unless future observations show a decided improvement in the blood picture we are not sanguine concerning the ultimate result. The expression by Dr. Cooley that these patients were making bricks without straw would seem to be a succinct statement of the state of affairs until such time as we can determine what factors constitute the straw.

The roentgen treatment consisted of five series at monthly intervals. The areas exposed were the spleen and the long bones of the legs, the latter as one area. One area only was treated at each visit, at which time 100 r was given with 6 mm. Al filtration at 40 cm. distance, 130 kv. On the alternate day the other area was exposed in like manner. This was done for two exposures over each area.

After the fifth month, treatment was discontinued and when the patient returned eight months after the first treatment was instituted, the improvement previously noted was observed.

We have included in this series a report of another case of erythroblastic anemia (Figs. 6, 7, and 8), through the courtesy of Dr. Ralph S. Bromer. This patient was also treated by radiation but with no improvement. The bones of this patient show almost as marked changes as those noted in our fatal case. The bone changes noted in the case which responded were not nearly so marked. The differences were: no changes in the calvarium, less marked thinning of the cortex, less prominent trabeculation and no marked cardiac enlargement. As the patient improved there appeared a greater tendency to transverse striation, particularly at the metaphyses, together with definitely increased density of the metaphyses.

For purposes of record, we have appended the report of a case of sickle cell anemia

Fig. 5. Case 11. Note the slightly increased bone density. Less marked trabeculation. Increased transverse striation, following roentgen treatment.

(Figs. 9 and 10), also through the courtesy of Dr. Bromer, and one case of celiac disease, on my own service, accompanied by profound anemia. The bone changes in sickle cell anemia, as noted roentgenographically, have already been pointed out by Vogt and others. They are similar in some respects to those found in erythroblastic anemia, but not by any means as profound. Nevertheless, the changes noted in our second case of erythroblastic anemia resem-

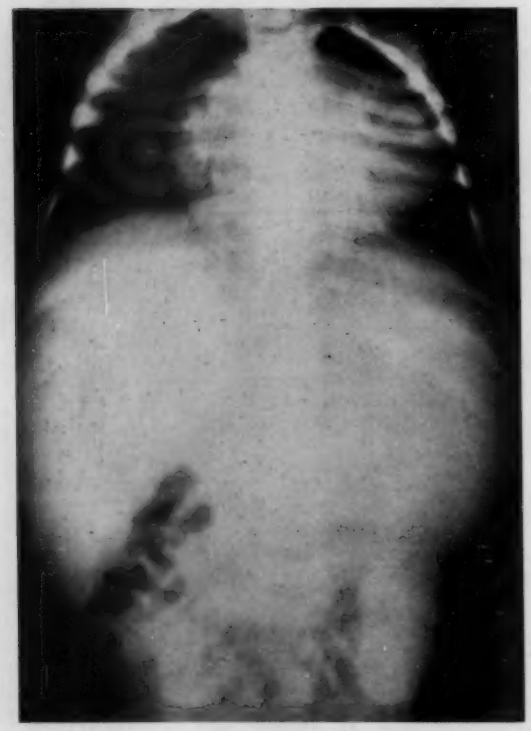


Fig. 6. Case III. Diagnosis, erythroblastic anemia. Roentgenogram shows enlarged globular heart; accentuated trabeculation of ribs.

ble somewhat more closely those of the case of sickle cell anemia. This would tend to bear out the observation already made by Cooley that the bone changes in the anemias of childhood are not primary. May it not be that the roentgen evidences of change are an index of the severity of the anemia?

With this thought in mind we have included a report of a case of celiac disease accompanied by profound anemia (Figs. 11 12, and 13). Celiac disease, or intestinal infantilism of Herter, is a disease of infancy, characterized by extreme carbohydrate intolerance. The diagnosis is based upon: retardation of growth, large, offensive, gray-colored stools, distended abdomen, peevish disposition and intolerance to carbohydrates. Reports of roentgen studies are rather meager. Neff says, "The bones are small and ossification of cartilages is delayed." Marriott reports essentially the same. Levinsohn states, "Osteoporosis is common, caused possibly by a negative balance or a B. avitaminosis. Spontaneous fractures occur. Delayed development of ossification centers are demonstrable. '*Year rings*', evidence of periods of delayed growth, can be seen by X-ray."

The patient presented certain roentgenographic evidences which led to a report of some form of congenital anemia before we saw the blood picture and without any knowledge of the clinician's diagnosis. We believe the evidences seen were due partly to the profound anemia and partly to the growth retardation as caused by the intestinal disturbance. The blood picture was as follows: Hemoglobin, 50 per cent; red blood cells, 3,330,000; white blood cells, 7,500; polymorphonuclears, 53 per cent; small lymphocytes, 38 per cent; large lymphocytes, 5 per cent; eosinophiles, 1 per cent; 5 normoblasts; 2 microblasts; 2 megaloblasts; red blood cells markedly irregular in size and shape.

Fig. 7. Case III. Note the characteristic cortical thinning, medullary rarefaction, prominent irregular trabeculation.

The spleen was somewhat enlarged. The skull presented only slight changes, characterized mainly by slight trabeculation, slight widening of medullary space particularly in the frontal and parietal regions. The pelvis showed definite trabeculation as did the femora and tibiae, with some suggestion in the hands and feet. The distal diaphyseal ends of the femurs and both diaphyseal ends of the tibiae presented some transverse striations, the so-called "year rings" of Levinsohn. The medullary portions of femora and tibiae suggested some osteoporosis. The scapulae and ribs also indicated accentuation of the normal trabeculation.

Although the anemia in this case was obviously a profound secondary anemia, undoubtedly the nutritional disturbance brought about sufficient demands on the reticulo-endothelial system to cause roentgen evidences.

Although the picture of erythroblastic anemia from a roentgenographic standpoint is totally dissimilar to that seen in this case of severe secondary anemia, there appear to be sufficient points in common between the less advanced case of congenital anemia and the secondary anemia to suggest further studies along these lines.

The opinions herein expressed are based on too few cases to warrant any presumption of conclusions.

Fig. 8. Case III. This also shows the characteristic cortical thinning, medullary rarefaction, and prominent irregular trabeculation.

CASE REPORTS

Case I. M. R., female, aged two. American born of Italian parentage. Admitted to Burlington County Hospital, New Jersey, September 23, 1931. Diagnosis of splenic anemia.

Chief Complaint. "Not enough blood."

Personal History. Normal infant at birth, normal delivery. One of twins, the other twin born dead. Weight 10 lb. at birth. Breast fed for eight months. Did well until six months old when she became pale and fretful. Lost weight. Admitted to Philadelphia Hospital. Remained for ten days, was given two transfusions, then taken home against advice. Has been under attention of various physicians since, with remissions and exacerbations. Appetite fair, no vomiting. Bowels regular. Frequent urination, dark in color at times. Abdomen had always been large. Apparently slight temperature at times. No cough or cold. Fretful. Mother not strong; father well. One older child living and well; one child dead, cause unknown; one child a year old suffering similarly to patient.

Physical Examination. Extremely pale and emaciated. Skin dry and of curious yellow color. Coughs frequently. Bluish white sclera. Mucous membrane pale. Enlarged tonsils. Some enlargement of lymph nodes of neck; those of axillae and groins palpable but not markedly enlarged. Respirations somewhat rapid, slightly impaired resonance. Breath sounds dimin-

Fig. 9. Case IV. Diagnosis, sickle cell anemia. Note the slightly transverse striation near the proximal metaphyses of tibiae.

ished over bases, posteriorly. No râles noted. Abdomen quite prominent. Liver apparently enlarged, palpable about 2 fingers below costal margin. Spleen markedly enlarged, palpable as mass extending to level of anterior superior spine. Definitely notched. Extremities grossly negative.

Roentgen Findings. October 24, 1931. Examination of the lower extremities and skull shows the following: The long bones of the legs show decided generalized decalcification with thinning of the cortex, some widening of the distal portion of the diaphyses of the femurs, an irregular porosity of the medullary portion with evidences of fine trans-striation, all of which are characteristic of an erythroblastic anemia. The calvarium shows distinct thickening of the frontal bone with some roughening and striations at right angles to cortex at the vertex and along the upper parietal region.

November 4, 1931. The upper extremities, ribs, vertebrae, clavicles and pelvis all show advanced evidence of the pathology noted in the lower extremities. The ribs are particularly porous and are almost devoid of any cortical ossification.

September 23, 1931. Examination of the chest shows the heart decidedly enlarged, globular in shape, with all its chambers much enlarged. The left apex shows great decrease in aeration. There is accentuation of all the peribronchial and parenchymal markings throughout both lungs with some evidence of slight studding in the left apex. The right interlobar pleural septum is somewhat thickened.

Conclusions. Cardiac enlargement. The pulmonary appearance is very much like that of bronchopneumonia.

Specimens sent to other laboratories for check-up showed from 158 to over 200 normoblasts; 66 per cent lymphocytes reported from one laboratory with the notation that quite a number of these might have been normoblasts. This was because of the apparent age of the smears that were submitted to the other laboratories.

The author has serious reason to believe that

Blood Examination

	9/25/31	9/27/31	1/6/32
Hemoglobin	25%	35%	35%
Red blood cells	2,180,000	2,210,000	1,120,000
White blood cells	47,900	80,250	26,800
Small lymphocytes	46%	Lymphocytes and lymphoblasts 73%	37%
Large lymphocytes	1%		4%
Neutrophiles	23%	21%	55%
Lymphoblasts	30%		Normoblasts 2
		Myelocytes 6%	Anisocytosis, poikilocytosis and polychromatophilia present in marked degree.
		Anisocytosis	
		Poikilocytosis	
		Polychromatophilia	
		Basophilic degeneration	
		Reticulocytes 3%	

the differential count made at the hospital was inaccurate because of the absence of a skilled pathologist.

During the course of illness the child developed evidences of pleural effusion with a bronchial pneumonia. Transfusion was resorted to in several instances. Roentgen treatment was applied, giving 100 r over the spleen. The patient's condition was such that further roentgen treatment was not permitted and the patient died on January 6, 1932.

Autopsy Report. Subject that of a female child, two years of age, markedly emaciated. No external abnormality found other than a transparency of the skin, peculiar of extreme anemia.

Thorax and abdomen opened through the usual midline incision.

Lungs: Freshly formed pleural adhesions found over both lungs, the right side being, however, more extensively involved. About 2 to 3 ounces of dark, flaky fluid found free within the left pleural cavity. Except for congestion at bases the lungs proper were found normally filled with air.

Heart: Increased amount of pericardial fluid and dilatation of the right side noted. The myocardium and endocardium, as well as the valves of the great vessels and heart, were normal. The mediastinal glands were enlarged somewhat but were discrete and not calcified.

Abdomen: Marked distention of the stomach as well as coils of small and large intestines. Other than this there were no gross abnormalities to be seen along the gastrointestinal tract.

Liver: Weighed 1 pound 6 ounces. It was dark brown in color, showing the unusual mottling due to increased lobular markings. Capsule was not thickened, stripped easily and showed no adhesions. Cut surface was somewhat granular and gave the impression of increased interstitial fibrosis.

Spleen: Markedly enlarged (weighed 4 oz.) and showed perisplenic adhesions over the posteromedial surface. It felt hard and nodular and was covered with an adherent thickened capsule. Cut surface was slate colored and granular, bleeding very little. Apparently there was marked increased interstitial and perivascular fibrosis.

Kidneys: Normal in shape and position. Capsule stripped easily and was of normal thickness. Cut surface showed normal proportion between thickness of cortex and medulla.

Fig. 10. Case IV. Shows the tendency to transverse striation in all metaphyses.

Mesenteric glands were enlarged.

Pancreas was normal.

A section of bone marrow was removed from the left tibia for microscopical examination.

Microscopical

Bone Marrow: Hyperplasia as shown by increased numbers of very young cells of the reticulo-endothelial series.

Lung: Areas in which alveoli are filled with fibrinous exudate but no migratory cells. Congestion of vessel around alveoli.

Gross Pathological Diagnosis: (1) Right-sided cardiac dilatation. (2) Pleurisy with effusion

Fig. 11. M.D., aged two, American. Diagnosis, celiac disease. Note the slight medullary rarefaction; somewhat thin cortex; transverse striations at metaphyseal ends; accentuated trabeculation of bones of the feet.

on the left and plastic pleurisy on the right side. (3)Hepatitis and splenomegaly (with fibrosis). (4) Bone marrow hyperplasia.

Case II. S. R., female, aged thirteen months, sister of Case I. Italian parentage, born in the United States.

Chief complaint on admission was paleness like older sister.

Personal History. Normal full term delivery. Breast fed for several months, then milk formula. At present time takes whole milk, cereals and vegetables. Has good appetite and normal stools. Her skin has been growing pale and yellow just as older child's did. Has no definite acute illness. Admitted for study.

Family History. Older sister in hospital with diagnosis of anemia. Father and one other child living and well. Mother living but not robust. Two children dead, one at birth and other from unknown cause.

Physical Examination. Poorly developed and undernourished Italian child of distinctly Mongoloid features, not as marked as those of the sister. The skin is a peculiar grayish yellow. Mucous membrane somewhat pale. Tonsils moderately enlarged. Lungs apparently clear. Abdomen prominent, liver slightly enlarged. Spleen enlarged, extending almost to umbilicus and downward to level of iliac crest. The remainder of the physical examination is irrelevant.

The temperature course was essentially negative.

Roentgen Findings. October 24, 1931. Examination of the lower extremities and the skull shows the following: The long bones of the legs present decided generalized decalcification with thinning of the cortex, some widening of the distal portion of the diaphyses of the femurs, an irregular porosity of the medullary portion with evidences of fine trans-striation, all of which is characteristic of an erythroblastic anemia. The calvarium fails to reveal any evidence of bone changes except for a slight tendency to thickening of the frontal bone.

November 4, 1931. Both upper extremities show the same characteristic evidences of thin-

Blood Picture

	10/24/31	11/15/31	
Hemoglobin	45%		25%
Red blood cells	2,390,000	2,600,000	1,590,000
White blood cells	28,450	43,500	7,100
Small lymphocytes	40%	52%	86%
Large lymphocytes	40%	52%	14% neutrophiles
Polymorphonuclears	34%	8%	1 Normoblast Red cell showing basophilic degeneration
Large mononuclears	26%	Lymphoblasts 32% Normoblasts 5% Marked anisocytosis Marked poikilocytosis Basophiles Several Cabot's rings	Anisocytosis and poikilocytosis

ning cortex as the lower extremities. The ribs also show suggestion of the same pathology.

Roentgen therapy was discontinued in June. Since that time the child's condition has been clinically improved. She has gained weight and strength and appetite is good. The spleen has been reduced until it is only partly palpable. The blood picture, however, is not materially improved and at the last examination hemoglobin dropped to 25 per cent. There is, apparently, some improvement in the aberrant cells.

Further roentgen examinations of the long bones showed no advance in bone changes and definite tendency to return to normal.

At the first examination, no attempt was made at an accurate differential count.

Second report: About this time, control examinations were made at several other laboratories and large numbers of normoblasts were found. We believe that because of local laboratory conditions existing at this time the differential examination was not as accurate as it should have been. This applied to most of the blood counts.

Case III. S. M., male, aged three, Italian.

Fig. 12. Same case as Figure 11. Shows accentuated trabeculation of pelvis and femurs.

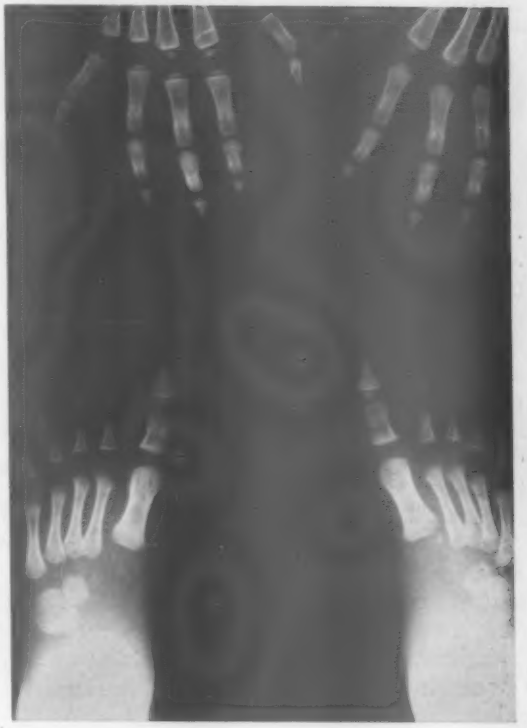


Fig. 13. Same case as Figures 11 and 12. Shows markedly accentuated trabeculation of hands and feet.

Admitted October 15, 1931, on service of Dr. Ralph S. Bromer, Children's Hospital, Philadelphia.

Chief complaint was large abdomen, weakness and paleness.

Provisional Diagnosis. Splenohepatomegaly.

Family History. History obtained from grandmother by interpreter. Mother aged twenty-five and father thirty; living and well. No other children. Paternal grandmother had asthma. No history of tuberculosis, nephritis or cancer.

Personal History. Born at easy labor, breathed immediately and seemed well. Birth weight 9 lb. Health during infancy was good until six months of age. Gained weight well. Sat up at three months. Never breast fed, given half milk and half water with a little sugar and lime water. Cod-liver oil and orange juice after seven months of age. Started to feed vegetables and bread at age of five months. Sleeps well unless eating before bed. Has had no contagious diseases or colds. Apparently well until six months old. At that time he began to vomit a great

deal nearly every day. When he would vomit much it was noted that he would have fever. The infant was given medicine by a doctor whereupon he improved somewhat but later vomiting and fever returned. Gained and lost weight spasmodically but did not gain steadily. After six months of age, his abdomen began to enlarge gradually for a year. Later it became larger and larger. Child was very constipated. After he was a year and a half old the abdomen seemed to remain stationary in size, but the constipation continued. He became more pale. About three months ago it was noticed that his abdomen became smaller, rather gradually and the constipation became less marked. He now has movements two or three times daily. Grandmother thinks he has improved during the last three months.

Physical Examination. Patient is a small and poorly nourished white male of about three years who does not seem acutely ill. He is somewhat jaundiced and has a very large abdomen in comparison with the rest of his body. Skin is jaundiced, otherwise negative. Glands—anterior cervicals are enlarged; epitrochlears can be palpated on the right arm. Head—large frontal bosses, forehead is high and square. Anterior fontanel is closed. Hair is thin, scalp has a few dry crusts. Ears—drums are both negative. Eyes—sclerae slightly yellow. Pupils react to light and are equal. Conjunctivae are pale. Nose is clean. Mouth—lips are pale, caries of a few teeth. Mucous membranes are clean and clear. Pharynx is clear. Tonsils are present but are not enlarged. Neck adenopathy present. No rigidity, pulsation of jugular can be seen. Chest is small and emaciated. Ribs stand out prominently. Pulsation of heart can be seen in the 5th interspace. Chest seems to be symmetrical. Lungs—breath sounds are vesicular. Percussion note is resonant, no râles. Heart rhythm is normal, apex beat is in the 5th interspace 1 cm. outside the nipple line; left border is about 1 cm. beyond the nipple line. A systolic murmur can be heard over the chest, loudest over the mitral area. Abdomen is very large. The spleen is easily felt, extending down into the pelvis. It is hard, smooth and the edge is rather sharp. The notch can be felt. When lying down the edge of the spleen can be seen through the abdominal wall. The liver is large and extends a full hand's breadth below the costal margin. It is soft and smooth, the edges are round. No tenderness and masses can be elicited. Extremities—no deformities. The musculature is poor. Patellar reflexes are well marked. Ankle clonus, Babinski's and Kernig's are absent.

Impression. Splenic anemia, or Gaucher's disease.

Blood Picture

	10/15/31	2/17/32	2/19/32	8/5/32
Red blood cells	2,930,000	2,820,000	2,820,000	1,630,000
White blood cells	23,000	16,600	15,000	6,600
Hemoglobin	25%	38%	52%	19%
Neutrophiles	52%		68%	78%
Lymphocytes	19%		20%	6%
Large mononuclears	15%		12%	2%
Eosinophiles	5%			10%
Basophiles	1%		Megaloblasts, 296	counting
Myelocytes	8%		Normoblasts, 438	100 W.B.C.
Polychromatophilia			Microblasts, 2	
Anisocytosis			Few degenerated cells	
Poikilocytosis			8/5/32	
Basic degeneration				
Howell-Jolly bodies				
Cabot's ring bodies, occasional				
Normoblasts, 281				
Megaloblasts, 36				
Mitotic figures				
Platelet count 260,000 per c.mm.				
Fragility test for red blood cells				
Beginning hemolysis 0.40				
Complete hemolysis 0.22				

Roentgen Report (Dr. Ralph S. Bromer). Examination of the spine and pelvis shows a slight tendency to rarefaction.

Long bones and skull. Perpendicular striations such as occur in erythroblastic anemias of the Cooley type or in the so-called congenital anemias. The changes in the long bones, namely, widening of the shaft and thinning of the cortex, with rather widely spread trabeculation shadows, and also perpendicular striations at the ends of the shafts, are typical.

Teleroentgenogram. There is a marked increase in the width of the right auricle and left ventricle shadows, also of the median arc, the heart having a globular shape. It is difficult to venture an opinion as to the cause of this without knowing more of the physical findings.

Treatment consisted of numerous blood transfusions with variable effect, mainly none. The child received an indefinite quantity of roentgen therapy but with no material change.

Splenectomy was then done, recovery satisfactory.

Further transfusions were given. Blood picture, however, failed to improve. Hemoglobin dropped to 15 per cent.

The patient was still living at the last report.

Case iv. T. G., Male, aged four, negro.

Roentgen Findings. The long bones show slightly increased density of the zones of the temporary calcification, while the skull shows marked thickening of the outer table of the vertex of the occiput, due, I believe, to the anemia. The typical perpendicular striations are not present.

Blood Picture

	2/17/32
Red Blood cells	2,930,000
White blood cells	36,000
Hemoglobin	42%
Neutrophiles	36%
Lymphocytes	53%
Transitional	8%
Eosinophiles	2%
Basophiles	1%

Complete sickling after standing overnight.
Polychromatophilia—slight
Achromia—slight
Normoblasts—7 found while counting 100 leucocytes

ROENTGEN IRRADIATION OF THE PARATHYROID REGION IN CYSTIC DISEASE OF THE BONES AND IN OSTEITIS DEFORMANS*

By E. A. MERRITT, M.D.
WASHINGTON, D. C.

IT IS not at all probable that cystic bone diseases have a common cause, but that many are dependent upon an increase of the parathyroid hormone is an established fact. To what extent this secretion influences other osteopathies and other diseases where calcium metabolism is involved furnishes abundant opportunity for speculation and study.

The inhibiting and destructive effects of radiation on the endocrines is of course well known, and the following cases are reported to show that the parathyroid glands are no exception to this rule.

A careful search of the literature fails to disclose any recorded evidence that roentgen therapy over the parathyroid region has ever been attempted as a therapeutic measure in cystic bone disease or osteitis deformans. One case reported here was classified as multiple myeloma, but the astonishing general improvement following roentgen treatment to the cervical region for the relief of pain raises the question if myeloma may not also be of endocrine origin.

Theoretically, at least, the best approach to parathyroidism is by radiation therapy and while all the cures of cystic bone disease hitherto reported have followed surgical removal of one or more parathyroid glands, there are and always will be obstacles which render surgical attack so difficult that irradiation, if reasonably successful, will become the method of choice.

Case 1. The patient, female, white, unmarried, aged thirty-four, was referred to our Clinic at Garfield Hospital by Dr. Bullock of Washington, D. C.[1] Family history unessential.

Past History. Usual childhood diseases. Had always enjoyed good health until January, 1928, when symptoms of hyperthyroidism developed. In addition to the cardinal signs there was a loss of 40 lb., insomnia, nausea, and vomiting, and marked muscular weakness. Prior to the subtotal thyroidectomy which was performed August 14, 1928, the B.M.R. was +23 per cent. Subsequent to the operation there was satisfactory general improvement to the point of perfect health for a year, when nervousness returned with all of the previous symptoms of hyperthyroidism which were thought by the patient to be "more severe than before operation." In addition, she complained of increasing stiffness and pain in the right knee which finally, together with symptoms of hyperthyroidism, produced complete disability. The patient was admitted by ambulance May 16, 1931.

Physical Examination. Emaciated white female, very nervous and apprehensive. Temperature 98.6°F.; pulse 98, respiration 20. There was a pronounced tremor of the fingers; slight bilateral exophthalmos; scar of a previous thyroidectomy with a rather firm bilateral moderate enlargement of the thyroid gland above scar; heart and lungs normal; abdominal viscera presented no demonstrable abnormality; B.M.R. +35 per cent; blood, urine and calcium determination not done; Wassermann negative; weight 95 lb.; right leg semi-flexed and could not be manipulated without producing excruciating pain in the knee joint. The knee was slightly swollen.

Roentgenograms of the right knee showed cyst-like areas of bone destruction involving the distal end of the right femur with definite periosteal proliferation. The cortex was broken through in places which doubtless permitted the egression of fluid resulting in bone proliferation. Chest and skull negative.

Treatment. Roentgen therapy was given to the neck over two areas including the thyroid and parathyroids, in the following dosage: 5

[1] Case report, *J. Am. M. Ass.*, May 13, 1932.

* From the Radiological Clinic of Groover, Christie and Merritt. Read in a Symposium on Malacic Diseases of Bone, Thirty-third Annual Meeting, American Roentgen Ray Society, Detroit, Mich., Sept. 27–30, 1932.

ma., 135 kv., 10-inch distance, 5 mm. Al filter, 6 minutes to each area.

On June 6, 1931, three weeks later, there was general improvement and almost complete relief of pain in the right knee. This attracted our attention and we, for the first time, noted the possible relation between the cystic bone disease, pain in the joint, and the parathyroids.

On June 27, the patient could walk very well without assistance and there was continued general improvement. The pain had entirely disappeared. Roentgen treatments were continued at three-week intervals to October 12, 1931, when there was scarcely a trace of hyperthyroidism or of the bone lesion.

The total number of treatments given was eight, the last being administered December 15, 1931, immediately after a basal metabolic rate determination, which was +16 per cent. The patient continued to gain in weight and health until the optimum of both was attained. She resumed her usual duties as a stenographer and was finally examined, photographed and discharged, September 12, 1932.

Fig. 1. Case 1. Cystic right femur before irradiation of parathyroids. May 16, 1931.

Fig. 2. Case 1. After irradiation of parathyroids. September 12, 1932.

Case II. Mr. X., white, married, aged fifty; referred by Dr. S. R. Karpeles of Washington, D. C., for general roentgen examination; occupation, designing draughtsman, Ordinance Department, U. S. Army. Family history unessential; wife living and well; one child aged twenty-four, living and well.

Past History. Rheumatism in 1923, in bed for two weeks; denies venereal disease; no tuberculosis contacts. Except as noted general health has always been excellent, and up to recent illness has been an active tennis player. Since 1917 he has averaged 1000 miles of railway travel per month in connection with his profession.

In February, 1929, patient was confined to bed for a day following a ride on a gun-carriage over a rough road. On March 6, 1929, while lifting a heavy weight he heard "something snap" in his back and experienced intense lumbar pain which, however, "lasted only a minute." He resumed work next day and continued thereafter with but slight back pain until December 15, 1929, when he was "taken with lumbago" and remained in bed for two weeks, returning to work January 2, 1930. July 1, 1930, found him in bed again with a lame back, and under a physician's care for two months. About this time he was advised by a social worker to have his back x-rayed, which was done in a commercial laboratory. The patient was then seen by two successive orthopedists and the rather unsatisfactory roentgenograms were also submitted to them. Neither of them appeared to have appreciated the nature or gravity of the case.

About September 21, 1930, he returned to work but suffered much pain in the back and could not lean over a drawing board or use a drafting machine. He was unable to raise a window, hold a telephone receiver to his ear or turn over in bed, and he discovered that his height had decreased from 5 ft. 8½ in. to 5 ft. 3½ in. He also noted an unusual prominence of his breast bone, a spinal deformity and pain radiating from back to left hip and thigh. Sneezing or coughing aggravated the back pain, and for two months before this examination the slightest exertion was followed by considerable difficulty in breathing.

FIG. 3. Case II. Cystic bone disease showing vertebrae at onset of disease. June 6, 1930.

FIG. 4. Case II. Six months after irradiation of the cervical region. August 10, 1931.

Physical Examination. March 2, 1931. Patient is emaciated, anemic, dyspneic, and obviously in considerable distress. He stands with

legs widely separated and supports his back by placing hands on his hips. Shoulders elevated and appear square across. Neck shortened and head held forward. Upper third sternum concave; lower two-thirds convex. There is a marked kyphosis with maximum convexity from the 3rd to the 8th dorsal vertebra. Skin shows evidence of pressure over this region. Lymphatic system negative; other special examinations negative except heart which showed evidence of failing compensation accompanied by organic disease, and marked secondary anemia, but with no unusual blood elements; normal calcium content; urine negative except for presence of Bence-Jones bodies. Temperature ranged from 94° to 98.6°F. while under observation and treatment at Garfield Memorial Hospital where he was admitted March 9, 1931.

Roentgen examinations showed myriads of cystic areas in all bones from the cervical vertebrae to the middle thirds of the femora. There was almost complete decalcification so that the bodies of the vertebrae scarcely registered on well made films. The last three lumbar vertebrae showed almost complete collapse and all the vertebrae showed marked narrowing. There was involvement of the proximal third of the right humerus. Chest examination showed evidence of chronic passive congestion and extensive involvement and deformity of the bony framework. Gastrointestinal study negative.

Fig. 5. Case II. Thirteen months after irradiation of the cervical region. September 12, 1932.

Fig. 6. Case III. Osteitis deformans of the left tibia before irradiation of the parathyroid region. October 8, 1931.

On the basis of roentgen findings and Bence-Jones bodies in the urine a diagnosis of "probable myeloma" was made.

Treatment. Absolute rest in bed. Special dietary measures for anemia, viosterol and deep roentgen therapy over lumbar, thoracic and cervical regions. A total of 1,800 ma-min. at 200 kv., 60 cm. distance, 0.5 mm. Cu and Al, over 9

FIG. 7. Case III. Same bone four months after irradiation of the parathyroid region. February 18, 1932.

areas, posterior and lateral lumbar, and posterior and lateral thoracic regions from March 9 to 28, 1931. Patient returned to his home April 5, 1931, considerably improved. He returned to the hospital May 12, 1931, for additional irradiation because of intense pain in the cervical region. A total to one area, posterior cervical region, of 600 ma-min. was administered in two treatments on successive days at 60 cm. distance.

March 30, 1931. Pain in back and left hip which had been an early and persistent complaint had almost subsided and there was "definite evidence of increased calcification in spine and pelvis" at this time. On May 15, patient returned to work putting in a 7 hr. day standing at the drawing board for 2½ hours. General improvement continued and the patient was presented, in person, September, 1931, together with the original roentgenograms and clinical laboratory findings, to the Bloodgood Bone Clinic in Baltimore by his physician and Drs. Merritt, Lindsay and Lattman, as a case of myeloma.

A practically unanimous opinion favoring this diagnosis was obtained at that Clinic.

Progress Notes and Summary. The patient has resumed his former occupation with no interruptions on account of his former disability. Roentgenograms show increasing calcification of all cystic areas and no new areas have developed except in the skull where some were noted in a recent examination.

The most striking improvement followed deep roentgen therapy to the cervical region and treatments have been resumed over this region on the theory that the case is one of widespread cystic bone disease resulting from hyperparathyroidism. The urine is now negative for Bence-Jones bodies. The patient was again studied at the Bloodgood Clinic, September 21, 1932, as a case of parathyroidism and this opinion was sustained by a large majority.

A careful check-up on the original roentgenograms made in June, 1930, shows a third lumbar vertebra which has the appearance of having exploded. This together with other bony lesions observed then and later plus the records of similar cases in the literature warrants a change in diagnosis from myeloma to parathyroidism.*

CASE III. Female, white, single, aged fifty-three, was referred by Dr. Bullock of Washington, D. C., for roentgen examination of the left leg. Family history unessential.

Personal History. Patient has experienced increasing intermittent pain and lameness in left leg for past year or more. Patient is a well-nourished female who appears to be about sixty years of age. General examination negative except for slight lameness of left leg and a saber-shaped deformity. Special examinations negative. Roentgen examination shows the characteristic findings of osteitis deformans in the left tibia only.

Treatment. Roentgen therapy over parathyroids: 5 ma., 135 kv., 10-inch distance, 6 minutes, 5 mm. Al filter, to each side of neck, every three weeks, as an experimental procedure. Following second treatment a roentgeno-

* This patient died June 9, 1933, of multiple myeloma, verified at autopsy, but no parathyroid glands were found.

gram of the affected bone showed a definite change. There was an appreciable diminution in the calcium content of the tibia; the cortices were much less dense and there was an actual decrease in the diameter of the bone. The patient has less pain and claims to "feel better." The patient was returned for roentgen study three times in as many days to confirm the above findings.

Four treatments in all were given and a subsequent roentgen study showed no essential change in the bone since previous examination.

Relief of pain following irradiation of the parathyroid region has been reported in two other well established cases of osteitis deformans observed by Dr. Lattman and myself and Drs. Coe and Otell, not here recorded because comprehensive data are not available at this time.

FOREIGN BODY REMOVAL WITH THE AID OF THE DOUBLE PLANE ROENTGENOSCOPE*

By WILLIS F. MANGES, M.D.
PHILADELPHIA, PENNSYLVANIA

SO FAR as I know, Grier,[1] of Pittsburgh, was the first to assemble a double plane roentgenoscopic apparatus. I remember seeing it in his office many years ago, and some years before I did the same thing.

My first work of roentgenoscoping in two planes was accomplished by moving the vertical roentgenoscopic apparatus to the side of the horizontal roentgenoscopic table. This was a very dangerous scheme because there were many assistants or spectators in the room and they were prone to approach the exposed high tension wires. As soon as possible we changed to apparatus which had the roentgen tube inside the high tension transformer case, so that the element of danger from electric shock was entirely eliminated.

At present we have one transformer mounted on a movable carriage under the table. Another similar transformer is mounted on a framework so that it can be raised or lowered and it is at one side of the table. Each transformer has a separate filament control and milliammeter, also a foot switch. The apparatus is shifted to one end of the table or the other, according to the side on which the foreign body is located, in order that the side containing the foreign body may be nearest the screen. I use a 6×8 inch screen with a wooden handle, and a magnifying glass, so that I have the screen in one hand and the magnifying glass in the other. The table was formerly a horizontal roentgenoscopic table. It has a canvas top and underneath the table on a framework there are tracks running lengthwise on which the transformer platform is moved, so that this transformer under the table can be moved the entire length of the table. We have extra wooden tops that are supported above this table on crosspieces. They bring the patient up to the proper height for the bronchoscopist. The ends are beveled in such a way that the patient's arms can be thrown downward and toward the head so that they are out of the line of vision for lateral roentgenoscopy. We have one of these for children and one for adults. The transformer that is mounted at the side of the table is on casters so that it

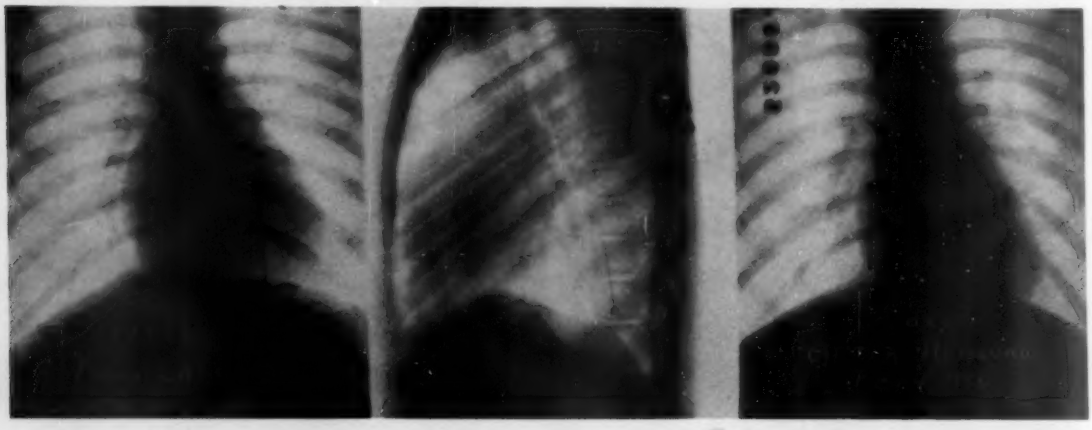


FIG. 1. The pin is beyond direct vision through the bronchoscope. Note that in neither view is it in line with the lower lobe bronchus.

* Read at the Radiological Conference, Philadelphia, Jan. 27–28, 1933.

can be moved to any point in the room. One can now buy better-looking and more flexible apparatus. Our outfit has the advantage of having proved successful in hundreds of cases, with less than 1 per cent of failure or mortality.

been the safety pin, but we have had numbers of pins, needles, nails, tacks, screws, toys, hairpins, bullets, staples, jewelry, dental foreign bodies, bird shot, etc.

The indications for use of the double

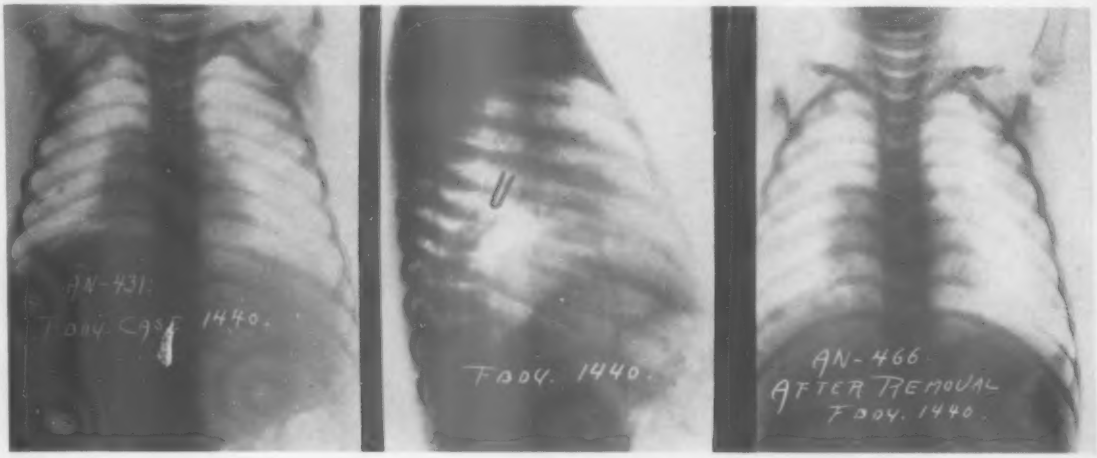


Fig. 2. The staple is surrounded by a dense process.

Jackson[2] has emphasized the dangers of attempting to use roentgenoscopy in one plane only, in the removal of foreign bodies in the bronchi.

The operation with a double plane roentgenoscope might also be dangerous if the bronchoscopist were inexperienced, and especially if both the bronchoscopist and roentgenologist were inexperienced. Our extremely low percentage of failures, and only one death in literally hundreds of cases, seem to prove the safety and value of the method under favorable conditions and in competent hands.

The vast majority of cases at the Jefferson Hospital have been foreign bodies in the bronchi, the esophagus, or the stomach, but we have also had cases of foreign body in the brain, quite a number of non-magnetic foreign bodies in the eye, in the neck, in lung tissue extrabronchial, in the abdominal viscera, and in soft parts generally throughout the body.

The foreign bodies have been of the greatest variety. The most common has

plane roentgenoscope are: (1) all opaque foreign bodies in the air passages below the larynx having sharp points (Fig. 1), irregular shape, cutting edges, projections, or length; (2) all opaque foreign bodies that lie beyond direct bronchoscopic vision, whether they are in anterior, posterior or lateral branches of the bronchi, or whether at too great depth for the bronchoscope to reach (Fig. 2); (3) all opaque foreign bodies that are associated with a pathological process that interferes with bronchoscopic vision; (4) foreign bodies that are extrabronchial (Figs. 3 and 4) but in close relation to fairly large bronchi, and that are not too large to be brought into the bronchoscope or into very close relation to the end of the bronchoscope; (5) in the esophagus, all open safety pins (Fig. 5); (6) all opaque, large, irregularly shaped foreign bodies below the level of the suprasternal notch; (7) all opaque foreign bodies associated with stricture of the esophagus or any pointed or long (Fig. 6) foreign body that lodges

and remains in the esophagus; (8) in the stomach, as a rule open safety pins of medium or large size should be removed; (9) opaque foreign bodies having length, such as nails, hairpins, etc.; (10) in any case where the patient has a pyloric or duodenal lesion, or any foreign body that remains in the stomach for more than a few days; (11) any foreign body that is apt to present an emergency if not promptly removed. For instance, Dr. Farrell helped in one case where a capsule of radium was removed from the stomach in this manner; (12) in the eye, any non-magnetic opaque foreign body in the eyeball or orbit that can be seen roentgenoscopically. It is extremely important that accurate localization with the Sweet Localizer or its equivalent be made before operation for removal of a foreign body in the eye is attempted; (13) in all other parts of the body where there is any opaque foreign body that for any reason demands removal. The simplest case sometimes turns out to be the hardest. Of this group, the most important one is the needle. It is commonly found in the palms

FIG. 3. The .22 caliber bullet is an extrabronchial foreign body. Note the relation of forceps to the foreign body above and of bismuth-insufflated bronchi to foreign body below. These exposures were made at the time of the first bronchoscopy. At the second operation, a special bronchoscopic forceps was made to penetrate the nearest small bronchus and then the bullet was grasped and removed through the bronchoscope.

FIG. 4. Shows the chest before and after removal of the bullet.

of the hands or in the feet. It is especially important to use the double plane roentgenoscope for removal of foreign bodies in soft tissues or hollow viscera when it is at all possible for the foreign body to be moved by surgical manipulation. The sense of touch cannot be relied upon to locate a foreign body when it is imbedded in soft tissue.

DUTY AND FUNCTION OF THE ROENTGENOLOGIST

The roentgenologist must assume responsibility for the amount of roentgen-ray exposure to the patient or the assistants. While I have had no accidents, I have often been filled with anxiety for a period of two weeks. One cannot measure the amount of radiation given during such an operation, but one can expose very small areas, divide the exposure as equally as possible in the two planes, and at every possible opportunity turn off the current—for instance, while the bronchoscopist is using the aspirator or changing forceps or shifting the patient to a better position or while he is trying to get a bronchoscopic view.

In bronchoscopic and esophagoscopic cases, one must be careful to avoid exposing the head or hands of the assistant holding the patient's head, also the nurse or assistant holding the shoulders of the patient. In surgical cases the surgeon and his assistant may get direct exposure. Eye cases particularly present risk to the operating surgeon when the lateral tube is used because his forceps are necessarily short and small so that his hand has to be close to the part to be viewed roentgenoscopically. One must be extremely careful to work with a very small diaphragm opening and be on the lookout for screen shadows of extraneous objects. I frequently call for light, to see that everyone is in a safe position and also tell each surgical assistant or nurse to keep the hands and arms out of line of the rays.

The tube under the table is about 24 inches from the patient. The rays are filtered through oil, 1 mm. aluminum, a canvas table top and 1 inch of wood. The ray from the lateral tube is filtered only by oil and aluminum and the tube may be from 18 to 24 inches from the patient, so that

allowance must be made in using the lateral tube.

An assistant keeps check on the time—tells me when fifteen, thirty, forty or fifty minutes are up. I use no more current in the tube than is necessary to enable me to see the foreign body and instruments. Depending upon the amount of current, and the character of the operation, as, for instance, whether I can interrupt the exposure frequently and shift from one tube to the other, we have worked as long as forty minutes, and in exceptional cases even one hour. However, this must not be taken to mean that I have exposed the same area of any one patient for as much as one hour. I would also warn one not to try to operate in this way for as much as one hour or even forty minutes until he has had considerable experience. It is much better to interrupt the operation than to produce a roentgen-ray lesion, unless some unusual emergency exists. I have often asked the bronchoscopist or surgeon to stop because I feared I was approaching the danger line.

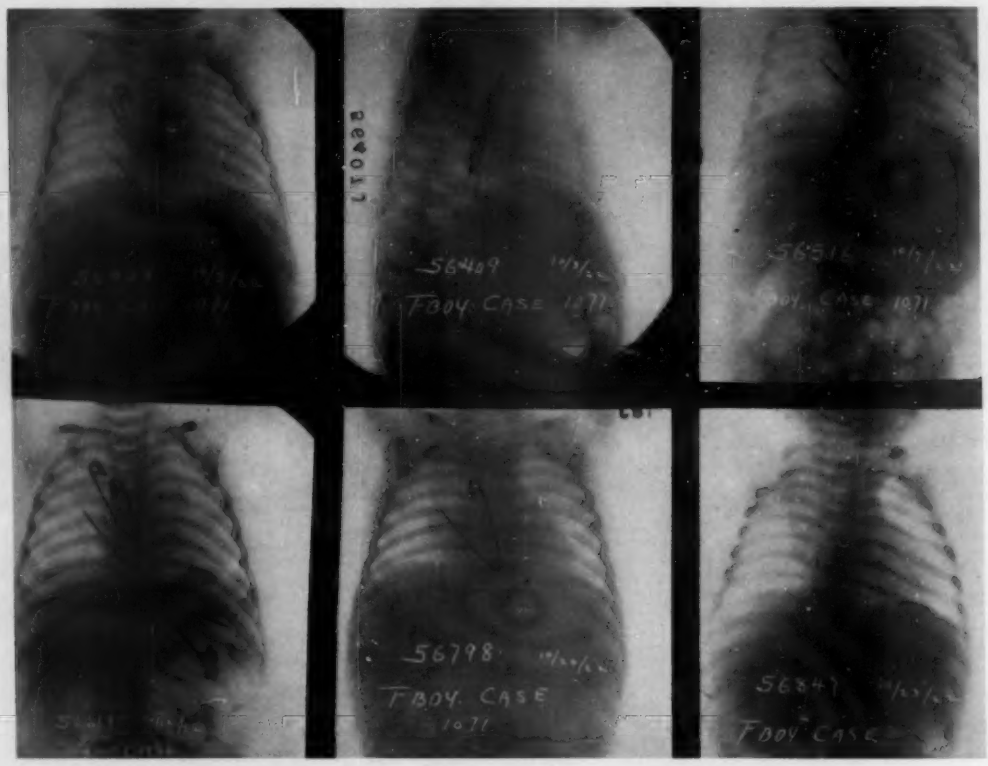


Fig. 5. Four large open safety pins in the esophagus of a baby nine months old were more or less entangled. At the first operation Dr. Jackson pushed the lower two into the stomach. They passed without harm to the baby. At the second operation the uppermost pin was taken out through the mouth. The remaining one was also removed by mouth at the third operation.

In such cases we wait for two weeks, if circumstances permit, before doing a second operation. A few patients have had two, three, four or more such sessions before the foreign body was finally obtained (Fig. 7). In two instances only have we been unsuccessful in removing the foreign body entirely in bronchoscopic cases. One was an open safety pin high up in the left upper lobe bronchus. We succeeded in getting the keeper branch but not the point branch. The pin was corroded and broke near the spring. The other was a needle, an extra-

bronchial foreign body, in the right middle lobe. It was extremely difficult to grasp and finally broke into three pieces, two of which were not recovered. The patient lived at a distance, went home, and did not return.

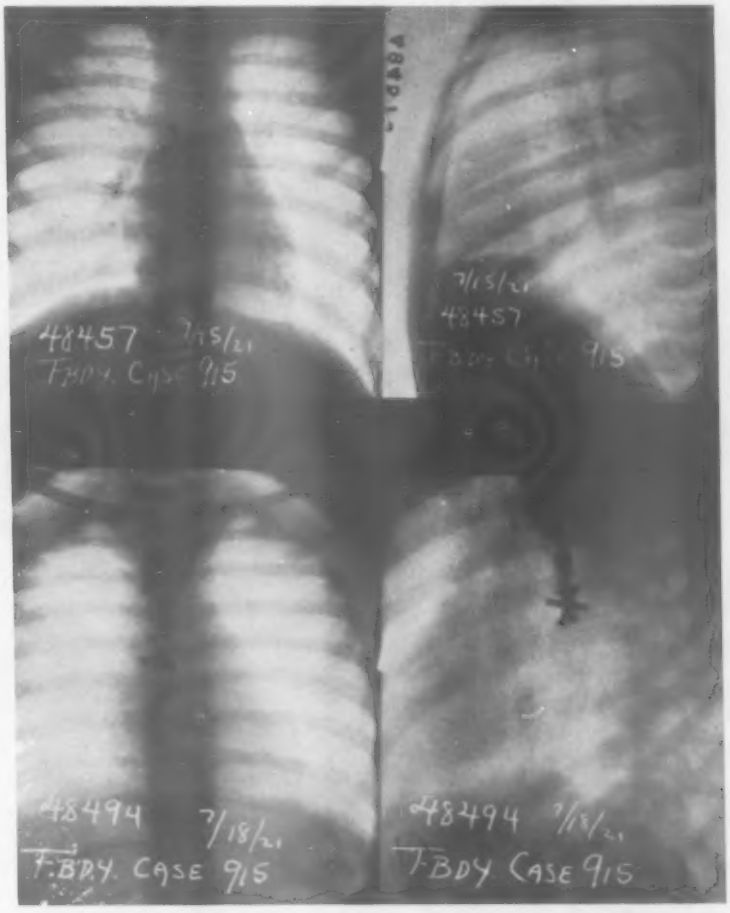


FIG. 6. Note that the jackstone is below a rather narrow stricture and is producing complete obstruction of esophagus. An attempt had been made by another surgeon to push the jackstone into the stomach. This produced definite injury to the esophagus. This foreign body was removed by the method described here and later the strictures were dilated to a satisfactory diameter. The foreign body was not visible to the bronchoscopist.

The roentgenologist also has a definite responsibility with regard to his own safety. I may be open to criticism when I say that in real difficult cases where frequent and rapid shifts from anteroposterior to lateral views are necessary, I have been wearing only surgical rubber gloves and not lead rubber. But I am extremely careful to have the screen cover the entire area of exposure; my hands, therefore, are never exposed to direct radiation. I use a well-protected screen, 6×8 inches, with a long wooden handle. This I keep in my left hand while in my right hand I hold a magnifying glass, also with a wooden handle. The advantages of the small screen are that it does not tire the operator to hold it a considerable length of time; it is possible to bring it in the closest possible relation with the part under observation; it can be shifted easily and quickly from one position to the other; it is not in the way of the bronchoscopist or surgeon as a larger screen

might be, and it makes one keep the area of exposure small, which is best for many obvious reasons.

Preparation of the eyes for roentgenoscopy is to be taken very seriously. A graduel and long-continued effort to get perfect accommodation in darkness is preferable to going from bright light to total darkness. I wear dark glasses while doing other work, for as much as an hour, if possible, before such an operation, and then just before cases in which the foreign body is small or deeply situated, I go from one degree of darkness to another to complete darkness until I go into the dimly lighted operating room, where, when not actually working, I keep my eyes shut or covered by my hands to keep out the light. I am certain that care in preparation has served me well in many difficult cases.

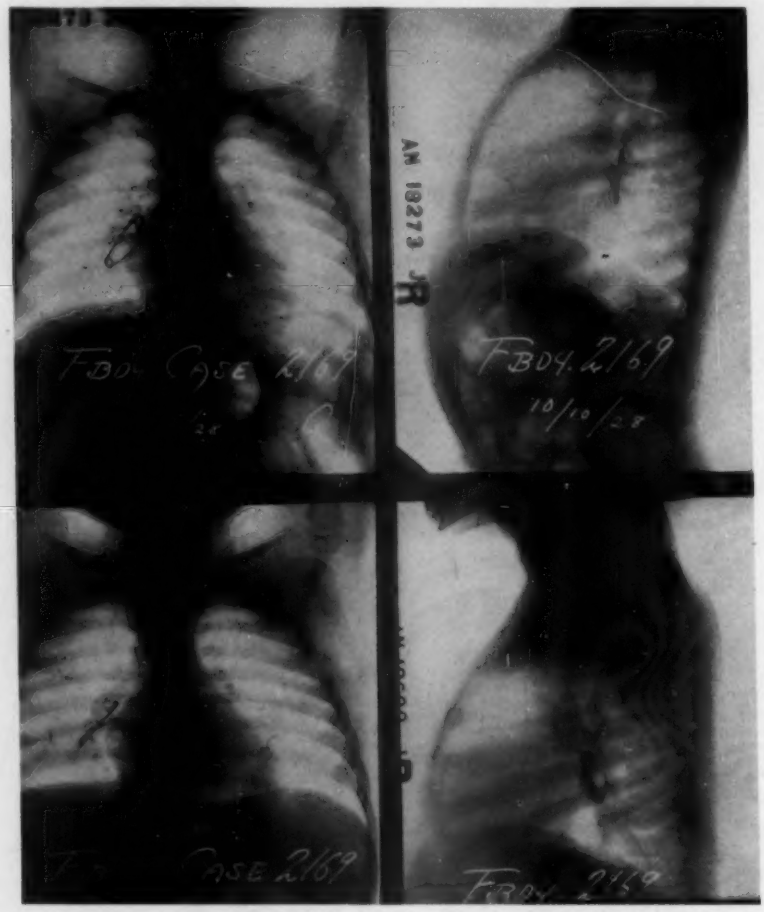


Fig. 7. Above, note bent point branch in close relation to heart. Below, note keeper branch is now close to heart and point branch is posterior. This change in position is all that was accomplished at the first operation. The pin was removed safely at a second operation.

Preliminary roentgen diagnosis and localization must be quite complete in order that as many as possible of the operative problems may be anticipated. This includes preliminary roentgenoscopic as well as roentgenographic localization, and especially when the foreign body is lacking in density and is, therefore, seen with difficulty roentgenoscopically. A good magnifying glass is a very important aid.

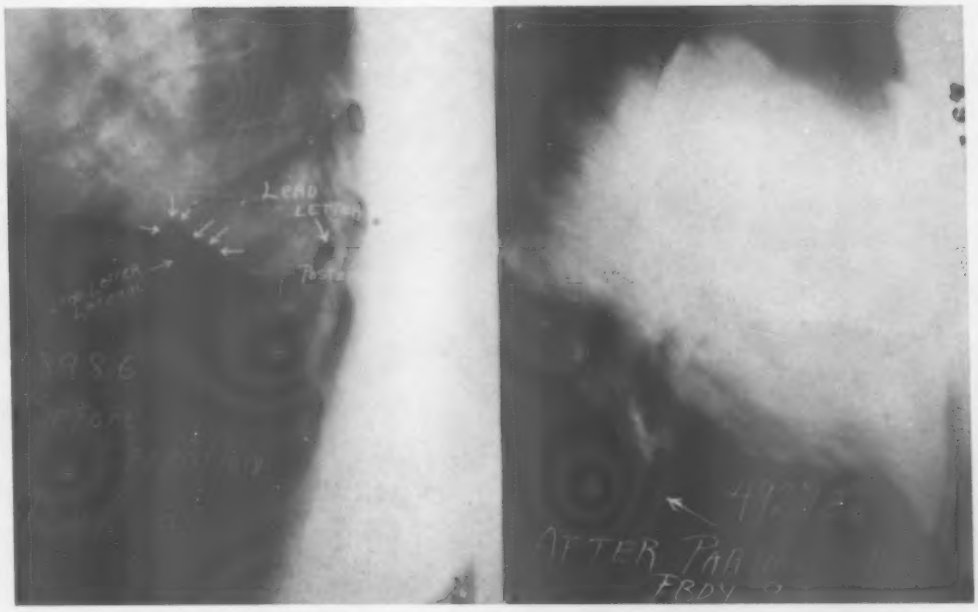


Fig. 8. Note lead letter "O" on posterior aspect and one on lateral aspect. Other arrows point to a faint shadow of a shawl pin.

One should not attempt to assist in removing a foreign body unless he has a definite knowledge that he can recognize the shadow of it in this way. I have occasionally used a method very similar to that described by Pancoast and Pendergrass[3]—that is, I have from previous roentgenograms in the anteroposterior and lateral views in as near the bronchoscopic position as possible determined at about what point on the surface of the body the central ray would emerge, and there I would place one lead letter "O" on the anterior or posterior surface and one at a similar point on the lateral aspect of the chest (Fig. 8); and then with the patient on the double plane roentgenoscopic apparatus make films to show the relation of the foreign body shadow to the path of the central ray and to the lead letter "O." Then, at the time of operation, it was easy to see the lead letters and to tell the approximate location of the foreign body. This method is especially valuable when there is a deeply situated localized infection that should be drained, whether the foreign body is removed or not, because the roentgenoscope

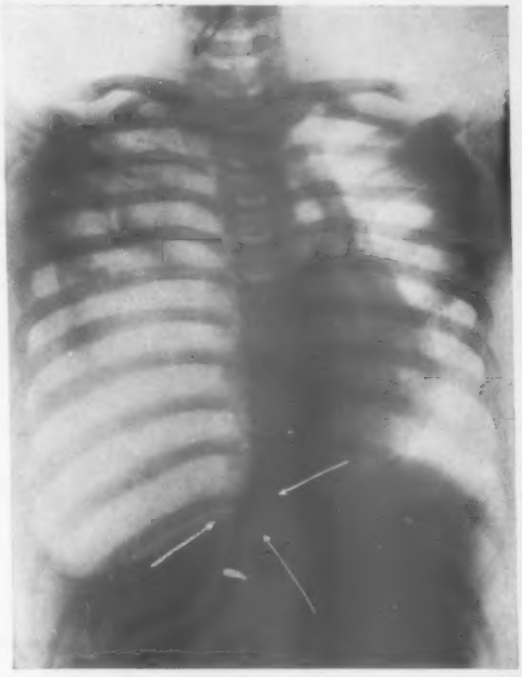


Fig. 9. A staple is in a completely compressed left lower lobe. There is also an extensive pyopneumothorax. The staple was removed surgically through an opening in the chest wall. The surgeon's forceps were directed into the collapsed lung by means of the double plane roentgenoscope.

at least guides the instruments to the area of infection. After bronchoscopic drainage or perhaps repeated drainages of such areas of infection the foreign body may at times become easily visible.

Whenever possible, a duplicate of the foreign body should be obtained so that the bronchoscopist or surgeon may make tests and select his instruments to the best advantage. Complications, such as penetration of the wall of the esophagus or bronchus by a pointed foreign body, the presence of an enlarged thymus, collapse of lung tissue, pneumothorax, exudate in the surrounding lung, etc., should be considered with the utmost care. For example, one foreign body (Fig. 9) in an area of collapsed lung may be removed via the bronchoscope while another may require surgical intervention. In one case a steel-jacketed bullet was found in a cavity in the left lung. It was easily possible for Dr. Jackson to get forceps through the bronchoscope into the cavity, but the bullet remained just out of the grasp of the forceps because the upper end of the cavity was the most dependent portion when the patient was in the recumbent posture. This problem was solved by placing a large magnet (Figs. 10 and 11) over the chest wall at the level of the bullet and drawing it downward, making the bullet go to the lower end of the cavity where it was easily possible to guide the forceps to a satisfactory grasp of the bullet, whereupon it was successfully extracted.

Fig. 10. A steel-jacketed bullet lies in the uppermost part of a cavity when patient is in a recumbent posture. Note that it is at too high a position for the forceps to grasp. At the second operation a large magnet was applied over the chest wall and by this means the bullet was drawn downward to a position where it was possible to have the forceps reach it. The bullet was then successfully removed with the bronchoscope.

I believe that Hickey[4] was the first to use a magnet to influence the position of a metallic foreign body so that it could be successfully grasped.

The operative problems sometimes change with the utmost suddenness, and many of our successes have been due to our ability —particularly because of the ability of Dr. Jackson and Dr. Clerf, with whom nearly all of my work has been done on bronchial, esophageal and gastric cases—to shift the plan of attack and take advantage of some favorable change in the operative problem. Again, success has come from the prompt,

courageous, but still careful act of instrumentation in the face of a crisis, such as suspended respiration. The roentgenologist must be prepared for sudden changes and keep the operator informed of the behavior of the foreign body.

It is extremely important that the bronchoscopist or surgeon and roentgenologist should understand each other with regard to the directions that are given during the operation. It should be remembered that the patient is not under an anesthetic and can hear everything that is said, so that, while it is necessary to speak frankly and with positiveness, yet one should avoid displaying a feeling of apprehension that might cause the patient unnecessary fear, or interfere with his cooperation to the fullest extent. In the case of young children this, of course, does not apply to the same extent. Simple terms are best in giving directions. I say "Go deeper," "Withdraw," "Go to left," "Go to right," "Go forward," "Go back," "Open your forceps laterally," "Open anteroposteriorly," "Now close forceps," "Hold," "Without opening forceps go left, right, back, forward, deeper, withdraw slightly," "You have hold of the keeper," "You have hold of the spring," "You have the extreme point in the forceps," "One point of the staple is outside the bronchoscope," etc. These are expressions commonly used and are understood.

Generally speaking, the forceps used for grasping the foreign body should be selected with the idea in mind of visibility as it involves the foreign body as well as the forceps. If the foreign body is small or slender, then the forceps blades should be slender, because with a large metallic shadow of forceps it is more difficult to recognize the delicate shadow of the foreign body than if the forceps image is also small. Many of the successes at the Jefferson Hospital have been due to the fact that there has always been a large variety of scopes and instruments to choose from, and often these are changed during the progress of the operation.

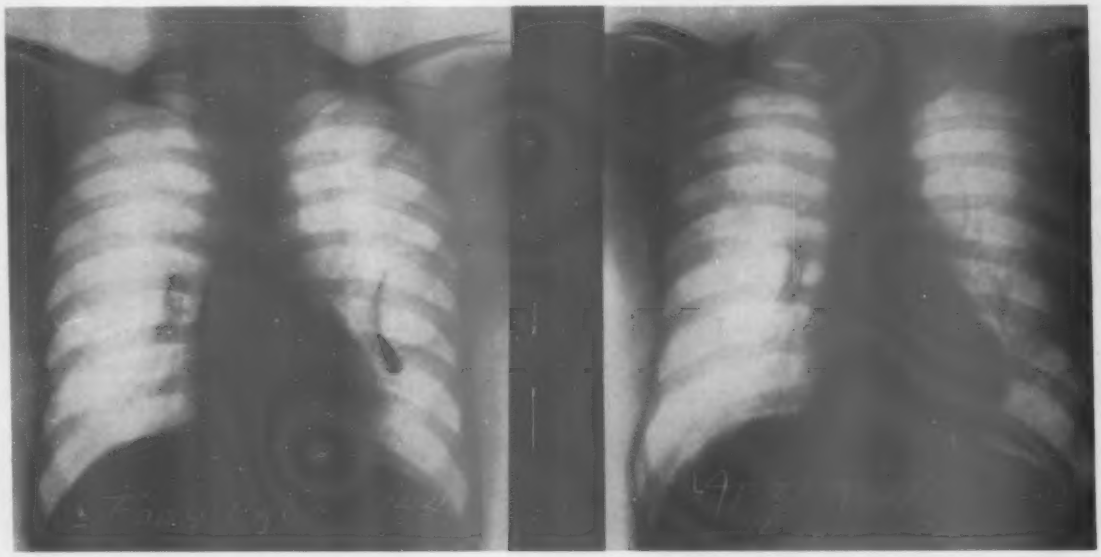


FIG. 11. Shows the chest before and immediately after removal of the bullet. Note that bullet is in dependent portion of cavity in erect posture.

The roentgenologist should acquaint himself with the mechanical problems from the bronchoscopist's or surgeon's point of view, so that he may be in a position to offer suggestions during the operation.

In bronchial cases one usually sees the roentgenoscopic images best in the dorso-

ventral view, while in esophageal cases he may see the shadows of foreign body and instrument to better advantage in the lateral projection. However that may be, it is best to have the operator open his forceps

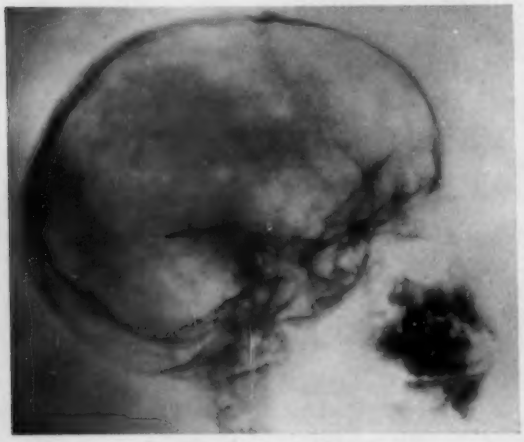


Fig. 12. A lateral view showing a nail deeply situated in the brain. It went in through the eyeball from an air rifle.

blades so one sees the space between them in the direction that gives the best view of the foreign body. This applies particularly to slender-pointed foreign bodies, such as the pin group. This is not a fixed rule, for a forceps opening in another direction and properly applied pressure may be just the thing needed to bring the point of a pin out of a lateral or oblique bronchial branch. When the foreign body is large and irregular, then the forceps opening must suit the conditions that prevail.

If the forceps grasp is not satisfactory for withdrawal, the operator sometimes tries to shift his instrument to a more favorable hold without letting go entirely, but, until the hold is safe, he is not told to withdraw it. In several instances of gastric foreign bodies, I have been able by palpation on the external abdominal wall either to bring a foreign body into relation with the forceps or to shift it in such a way as to improve the grasp of the forceps.

When the foreign bodies are in the trachea, bronchi, esophagus or stomach, one is working in a natural passage and cutting instruments are not used, so that one can work almost entirely by roentgenoscopy and in the dark. But, when directing the surgeon to a foreign body, the operation must be done partly with light so that he can proceed to greater depth in the tissues without destroying vital or important anatomical structures; and then, with a blunt instrument in the depth of the wound, the relation between this instrument and the foreign body is determined roentgenoscopically. If the instrument is almost in contact and there are no surgical contraindications (Figs. 12 and 13), the surgeon can be directed to grasp a bit of tissue in the end of the forceps and then, in the light, proceed again in the proper direction surgically. In this manner the foreign body is finally reached without much trauma to the surrounding tissues and with no more cutting than necessary. Here, again, the problems vary a great deal and one must be prepared for these variations to occur during the operation. I should perhaps say that all the surgeons with whom I have

Fig. 13. Frontal view of nail. This was successfully removed through a small trephine opening on the double plane roentgenoscopic table.

worked have the greatest desire to put their fingers into the wound to try to feel the foreign body. This is a great mistake because it so often happens that the foreign body can be moved from one place to another with very little effort. This is especially true of needles or foreign bodies in the intestines.

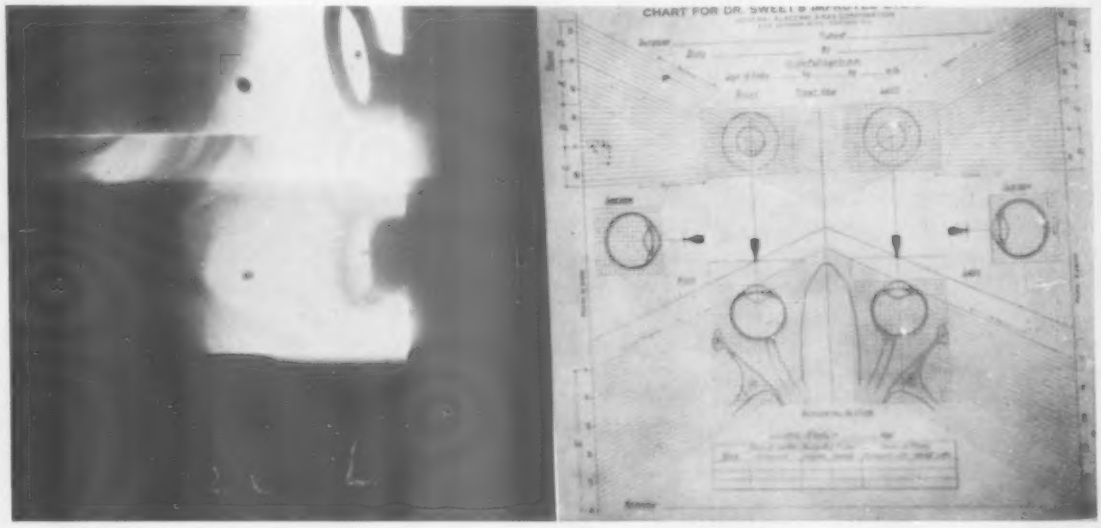


Fig. 14. Shows a bird shot in the posterior chamber of the left eye. Note location as shown on localization chart. Successfully removed.

The operation on the eye is the most delicate of all in some respects (Fig. 14). In the first place, it is difficult for the patient to hold still, because, while the external coat of the eyeball is under the effect of cocaine, no anesthetic is used inside the eye, and it is therefore painful if the forceps come in contact with the retina. In the second place, the foreign body is in a semi-liquid medium, the vitreous, and for that reason the forceps grasp must be very accurately directed or the foreign body will go to one side or escape from the end of the forceps. In the third place, in some cases it is extremely difficult to see the foreign body shadow in the anteroposterior direction. In two of our cases, there were multiple shot in the tissues around the eye and in the eyelids, but with only one shot in the eye in each case. In one of these, the shot was so small that I could not see it in the anteroposterior direction. We were fortunate enough, however, to get it with the aid of the lateral tube alone. All of these eye cases have been done with Dr. George H. Cross[5] doing the surgical operative work, and, thanks to his great skill, we have now had 12 cases of bird shot and one case of a piece of copper inside the eyeball all successfully removed and no failures.

In one case it was considered advisable to remove the shot as soon as possible, and we accepted the localization of another roentgenologist who had plotted the location of the shot to be inside the eyeball. At operation it was possible to determine roentgenoscopically that the forceps could not come into actual contact with the shot. There was a space of about 2 or 3 mm. between the two. Later the eyeball was removed and the shot was found to have penetrated the posterior wall of the eyeball and lay just on the surface of it.

Again, one should never attempt to aid in removal of a foreign body from any portion or organ of the body that he cannot see roentgenoscopically with certainty, and he should avoid being impatient or in a hurry.

The work that I have done in this way has been done always under the most favor-

able conditions, so far as my part was concerned. Especially was this true in the bronchial, esophageal and gastric cases, because from the first I was under the masterly control and influence of Dr. Jackson, and then his very skillful successor, Dr. Clerf. The successes I have shared in were their successes.

REFERENCES

1. Grier, G. W. Fluoroscopic bronchoscopy. Am. J. Roentgenol., 1916, *3*, 123–125.
2. Jackson, Chevalier. Bronchoscopy and Esophagoscopy. Second edition. W. B. Saunders Co., 1927, p. 224.
3. Pancoast, H. K., and Pendergrass, E. P. Localization of foreign bodies in the lung by roentgen examination. Am. J. Roentgenol. & Rad. Therapy, 1932, *27*, 225–233.
4. Hickey, P. M. Foreign bodies in the oesophagus and the lower air passages. *J. Mich. M. Soc.*, 1910, 1–3.
5. Cross, George H. Removal of nonmagnetic foreign bodies from the vitreous. *Pennsylvania M. J.*, 1931, *34*, 478–481.

Vol. XXX, No. 5

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

Editor: Lawrence Reynolds, M.D.
Assistant Editor: Ruth Bigelow, B.S.
Editorial Board: A. C. Christie, M.D. E. H. Skinner, M.D. Lauriston S. Taylor
Advisory Board for Pathology: James Ewing, M.D. Eugene L. Opie, M.D.
Collaborating Editors: The Officers and Committee Members of the Societies of which this Journal is the official organ, whose names appear on this page, are considered collaborating editors of this Journal.
Foreign Collaborators: A. Béclère, M.D., Paris, Gösta Forssell, M.D., Stockholm, G. F. Haenisch, M.D., Hamburg, R. Ledoux-Lebard, M.D., Paris.

Publisher: Charles C Thomas, 220 East Monroe St., Springfield, Illinois

Issued Monthly. Subscription $10.00 per year, $11.00 in Canada and $12.00 in foreign countries. Advertising rates submitted on application: Editorial office, 110 Professional Building, Detroit, Mich. Office of publication, 220 E. Monroe St., Springfield, Ill. Information of interest to all readers will be found on page iv.

Officers and Standing Committees

THE AMERICAN ROENTGEN RAY SOCIETY

President: John T. Murphy, Toledo, Ohio; *President-Elect:* George W. Grier, Pittsburgh, Pa.; *1st Vice-President:* L. R. Sante, St. Louis, Mo.; *2d Vice-President:* H. J. Walton, Baltimore, Md.; *Secretary:* E. P. Pendergrass, University Hospital, Philadelphia, Pa.; *Treasurer:* E. L. Jenkinson, 1439 S. Michigan Ave., Chicago, Ill.; *Historian:* E. H. Skinner, Kansas City, Mo.

Executive Council: John T. Murphy, George W. Grier, L. R. Sante, H. J. Walton, E. P. Pendergrass, E. L. Jenkinson, Lawrence Reynolds, J. Bennett Edwards, B. R. Kirklin, L. Jaches, W. A. Evans, Charles L. Martin, Sherwood Moore, Merrill C. Sosman, Chairman, Peter Bent Brigham Hospital, Boston, Mass.

Committee on Laws and Public Policy: F. M. Hodges, Richmond, Va., W. E. Chamberlain, Philadelphia, Pa., L. R. Sante, St. Louis, Mo.

Committee on Safety and Standards: A. U. Desjardins, Chairman, Rochester, Minn., T. Leucutia, Detroit, Mich., W. D. Coolidge, Schenectady, N. Y., G. E. Richards, Toronto, Ont., F. J. Hodges, Ann Arbor, Mich.

Publication Committee: B. R. Kirklin, Chairman, Rochester, Minn., Ross Golden, New York City, Ralph S. Bromer, Bryn Mawr, Pa.

Finance Committee: J. Bennett Edwards, Chairman, Leonia, N. J., Leslie R. Hess, Hamilton, Ont., Raymond C. Beeler, Indianapolis, Ind.

Board of Censors: A. B. Moore, Chairman, Washington, D. C., L. Jaches, New York City, W. A. Evans, Detroit, Mich.

Committee on National Board of Examiners for Radiology: B. R. Kirklin, Rochester, Minn., L. R. Sante, St. Louis, Mo., W. F. Manges, Philadelphia, Pa.

Member, National Research Council: M. C. Sosman, Boston, Mass.

Editor: Lawrence Reynolds, 110 Professional Building, Detroit, Mich.

Assistant Editor: Ruth Bigelow, 110 Professional Building, Detroit, Mich.

Editorial Board: A. C. Christie, E. H. Skinner, Lauriston S. Taylor.

Advisory Board for Pathology: James Ewing, Eugene L. Opie.

Thirty-fifth Annual Meeting: Pittsburgh, Pa., Sept. 25–28, 1934.

THE AMERICAN RADIUM SOCIETY

President: Rollin H. Stevens, Detroit, Mich.; *President-Elect:* William H. Cameron, New York City; *1st Vice-President:* George W. Grier, Pittsburgh, Pa.; *2d Vice-President:* John W. Cathcart, El Paso, Texas; *Secretary:* Edward H. Skinner, 1932 Professional Bldg., Kansas City, Mo.; *Treasurer:* Zeo H. Johnston, Jenkins Arcade, Pittsburgh, Pa.

Executive Committee: H. J. Ullmann, Chairman, Santa Barbara, Calif., Sanford Withers, Denver, Colo., Burton J. Lee, New York City.

Program Committee: Wm. H. Cameron, Chairman, New York City, Maurice Lenz, New York City, E. H. Skinner, Kansas City, Mo.

Publication Committee: E. H. Skinner, Chairman, Kansas City, Mo., B. F. Schreiner, Buffalo, N. Y., Douglas Quick, New York City.

Research and Standardization Committee: G. Failla, Chairman, New York City, H. J. Ullmann, Santa Barbara, Calif., R. B. Greenough, Boston, Mass.

Education and Publicity Committee: G. E. Pfahler, Chairman, Philadelphia, Pa., C. L. Martin, Dallas, Texas, J. S. Ullman, Natchez, Miss.

Committee on National Board of Examiners for Radiology: Henry Schmitz, Chicago, Ill., R. H. Stevens, Detroit, Mich., H. K. Pancoast, Philadelphia, Pa.

Nineteenth Annual Meeting: Cleveland, Ohio, June 10–11, 1934.

EDITORIAL

ROENTGENOLOGY OF THE GASTROINTESTINAL TRACT

WHEN the printing house of J. Oporinus issued Vesalius' famous "Fabrica" in 1543 the work was so complete and detailed in every feature that no real additional anatomical information was added till the introduction of the microscope almost two hundred years later, and it was not until 1833 that Beaumont published his experiments on Alexis St. Martin which for many years were the only fundamental observations made on the action and function of the stomach and the part it plays in digestion. It awaited the introduction of the roentgen ray into the field of medicine before any further progress was made beyond these original experiments of Beaumont's other than such information as might be gained by the introduction of tubes into the mouth, stomach and duodenum from which the chemical features of digestion were gradually elucidated. However, the movements of the alimentary canal could only be determined indirectly by the introduction of balloons and other devices to indicate the pressure changes, or by inference from experiments on animals under anesthesia. While these experiments added considerable fundamental knowledge, the information gained could not be wholly translated into human terms and those of us who have to do with the daily routine of roentgenological problems scarcely appreciate the fact that the information upon which we base our diagnosis as regards gastrointestinal conditions has, for the most part, been laboriously and patiently built up during the last twenty-five years.

Dr. A. E. Barclay, in his book on "The Digestive Tract" recently published,* has called attention to the fact that roentgenology has been so successful in the diagnosis of pathological conditions that there is a tendency to overlook its applications to anatomy and to physiology. The early workers were faced with the fact that the orthodox anatomy and physiology of the alimentary tract were hopelessly at variance with what they saw. By degrees they worked out the normal as far as they could and today the roentgenologist turns to roentgenological works and not to textbooks of physiology or anatomy for help in interpretation, because these textbooks are based upon studies made in the postmortem room or in the dissecting laboratory, and what the roentgenologist sees is the living anatomy and living physiology which have not as yet found their way into textbooks.

It is a bit unfortunate, Barclay says, that the utilitarian demands of the time necessitated the use of the roentgen ray in the diagnosis of pathological conditions and that while we have built up as a result of these studies an enormous amount of information which deals with the pathological, there still remains a great deal of work to be done in the realm of the use of the roentgen ray in the study of the more purely physiological problems. These studies are necessitated by the fact that the roentgenologist is dealing with the living functioning human being. Not only do mental influences affect the form and position of the stomach but many mechanical factors are responsible for the change in the shape of the stomach such as the posture of the subject and the tonic action of the intrinsic muscles, the movements of the diaphragm, the distention of the organ by the bulk of the food as well as by the weight of the

* Barclay, Alfred E. The Digestive Tract: A Radiological Study of its Anatomy, Physiology, and Pathology. Cambridge University Press, London, 1933.

food, though to a small extent only, and the stomach is also influenced by pressure from other organs. Nature, he states, has no set patterns either in form or in function; she varies her methods ceaselessly and the more we see of the inner workings of her mechanics and chemistry, the more we realize that they constitute a kaleidoscope of balanced form and function, the mutations of which are utterly bewildering to those who attempt to describe and tabulate them. It is therefore highly artificial to separate form from function or anatomy from physiology because in life these three melt imperceptibly into one another and to the roentgenologist who studies living conditions there is no artificial dividing line. What he sees is a living factor; there are no sharp divisions or walled-off departments; he sees anatomy, physiology and pathology as one whole. The form, the shape of the stomach is anatomy, yet a slight deficiency of tonic action, a physiological change, may alter the picture completely, while the presence of a contraction may be pathological or merely a physiological response to some stimulus remote from the stomach itself.

Dr. Barclay, in his splendid book, calls attention to things of such fundamental importance as the movements and excursions of the diaphragm and the various levels of the diaphragm at inspiration, expiration and at rest. He was one of the early workers in this field of physiology and he stresses the essential difference between the study of the living in regard to the position of the diaphragm as compared with the formal textbook discussions on these subjects. He emphasizes the influence of the movements of the diaphragm on the gastric function and calls particular attention to the shape and disposition of the abdominal contents. He also stresses a fact well known to roentgenologists that there is considerable misunderstanding of the so-called "gastroptotic" or "dropped" stomach, emphasizing that the shape of the stomach is easily altered by pressure of intra-abdominal structures or even by gas in the intestine. Not only is attention directed to the extreme mobility of the stomach but, as a result of some ingenious studies, he has pointed out this feature of other intra-abdominal organs as well as of the kidneys, and from these composite studies he has shown how utterly fallacious is the conception of fixity conveyed to the student by descriptions based on observations on the dead body, and that fixation of the viscera in definite positions in relation to the abdominal wall and to each other is foreign to nature.

One of the many excellent chapters in Dr. Barclay's book is devoted to a study of the normal mechanism of swallowing, the author himself having made many fundamental observations along this line. He calls attention to the extraordinary fact that so little research seems to have been carried out on the mechanism of swallowing, an act which is of such supreme importance to a person's well-being, and that gravity which has always played such an important part in any discussion of the act of swallowing is in reality a negligible quality. He has found that the process of swallowing as seen roentgenologically consists in three fundamental changes, namely, the whole larynx rises; suddenly the pharyngeal space is obliterated, just for a fraction of a second, before the food slips over the back of the tongue; the pharyngeal space usually appears again and into it comes the swallowed opaque mass. It appears to be just thrown back into this cavity by the action of the tongue, and it seems to shoot as though through space, at a tremendous speed, as if the cavity had no walls. The bolus, as it travels, gives the impression of being sucked rather than pushed down and negative pressure plays an important part in the mechanism of swallowing. Obviously, swallowing is not the simple, almost peristaltic, movement that it was once considered.

The introduction of the opaque meal has completely disproved the previously taught ideas of the stomach as an organ consisting of two parts, the upper acting as a hopper in which the food was stored and the lower

as a mill in which it was thoroughly mixed and churned until a given degree of acidity was produced, causing the pylorus to open allowing the food to pass. The stomach is now seen as a living tubular muscle, a sensitive organ, perhaps, as Barclay says, the most sensitive muscular organ in the whole body. Its shape depends on its tone and the tone may alter from moment to moment in response to a great variety of physical and psychical stimuli; it is a "fluid" organ which changes its shape not only in response to tone but in response to its peristalsis, the gastric peristalsis varying enormously, as all roentgenologists have had occasion to observe, not only with the individual but from time to time in the same individual. The forceful churning waves that were described in the early observations are not the usual type of peristaltic movement seen in man under normal conditions. Peristalsis in the normal subject is not a forcible movement and Barclay aptly describes it as suggesting "the waves that running shorewards help the sea-drift on its way, rather than the breakers beating upon the rocks." He agrees with Alvarez that the forces which bring about, modify and control peristalsis must be looked for mainly within the walls of the gut itself. It is a fact that at present little is known about the exact method of conduction of the wave of gastric contraction, and one of the fundamentals of digestion, namely, the control of the pyloric sphincter, is as yet almost entirely unknown. Certain it is that the opening of the pylorus does not depend on the acidity or alkalinity of the food.

Barclay, in conformity with most observers, has found it extremely difficult thus far to study satisfactorily the small intestine and he believes that the study of the movement of the food or opaque meal through the small intestine will come when more adequate technique, such as efficient cinematographic roentgen-ray studies, are possible.

From his study of the large bowel Barclay is convinced that the slow peristalsis which was formerly described in the large bowel does not take place and he agrees with Holzknecht, Case, and others, that the movement of the material in the large bowel is a "mass movement," that this mass movement is dependent on the formation of a definite constriction, a *point d'appui*, and in the majority of cases this *point d'appui* occurs near the hepatic flexure. The colon distal to the constriction loses its haustral segmentation and the colonic contents seem to back up to the point of constriction as if forming a mass ready to be propelled onwards when the mass movement takes place. The whole column on the distal side of the *point d'appui* or constriction is swept along. The *point d'appui* has also been observed in the splenic end of the transverse colon. Dr. Barclay is convinced that the keystone to the efficiency of this mass movement of the large intestine lies in the competence of the *point d'appui;* in addition to the mass movement changes are from time to time seen in the shape of the haustral segments of the large intestine, especially the transverse and descending colon. Barclay points out the fact that the problem of the passage of the food through the large intestine is full of difficulty, not only because the observations are few and far between in spite of the vast number of patients examined, but also because the whole conception of mass movement is revolutionary and alien to the traditional line of thought, and he says it is regrettable that we have been brought up on an armchair conception of what takes place, for unconsciously we attempt to make our observations fit in with our preconceived notions and the whole subject of the physiology of the colon seems to be in chaos as there is no satisfactory basic knowledge. Most of the literature on the colon, which is voluminous, has to do with its diseases, and because our fundamental physiological knowledge of the colon is so limited we derive little profit from either the clinical or roentgenological study of the large intestine, except in a very few definite and specified conditions such as neoplasm, diverticulosis and poly-

posis, and the knowledge of so important a subject as constipation is still extremely confused. Barclay raises the question as to whether constipation, per se, is a pathological condition or one of disordered physiology. His own observations have led him to believe that there are three types of constipation: in an absence of mass movement, inertia of the colon; stagnation in the cecum, and stagnation in the rectum. Of these colonic inertia is the most frequent, and if the mass movement is not effective there is nothing but the comparatively feeble movement of the cecum to propel the feces onward; that is, the mass in the cecum itself has to act as the *point d'appui*. The part played by the cecum in the movements in the large bowel is not clear but Barclay's deductions have led him to believe that this portion of the large gut has a separate mechanism or peristalsis for mixing the contents and feeding them into the ascending colon preparatory to the mass movement. Rectal stagnation, Barclay believes, is in reality a fault of defecation often acquired through neglect of the call to stool, rather than a true constipation. But certain pathological conditions of the colon, namely, neoplasms proximal to the rectum, often give a ballooning of the rectum which would lead to the inference that rectal stagnation may have an additional cause such as some disturbance in the propagation of the peristaltic wave through disturbance in the nervous mechanism.

It is difficult for the roentgenologist of today to appreciate the laborious amount of work and the infinite details which the early investigators carried on in order to perfect the diagnostic signs which are used with such facility and ease today. But in the study of the pathological conditions it must be understood that in "radiology as in every branch of medicine the diagnosis of the abnormal can only be based on a thorough recognition of the normal and an appreciation of the limits of normality." Dr. Barclay in his discussion of the normal and its variable picture has admirably prepared the ground for a point of departure and further study into the less understood realms of the physiology of the gastrointestinal tract. There remains, as he says, much to be done in this field of endeavor, and the stimulus of this timely book should incite many workers to a further inquiry by roentgenological means into the normal physiology of the gastrointestinal tract.

SOCIETY PROCEEDINGS CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. E. P. Pendergrass, University Hospital, Philadelphia, Pa.
Annual Meeting: Pittsburgh, Pa., Sept. 25-28, 1934.

American College of Radiology
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual meeting: Cleveland, 1934.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio.
Annual meeting: Cleveland, Ohio, June 11–15, 1934.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y.
Annual meeting: 1934, to be announced.

Radiological Section, Los Angeles County Medical Society
Secretary, Dr R. T. Taylor, Los Angeles, Calif.
Meets on the third Wednesday of each month at the California Hospital.

Radiological Section, Southern Medical Association
Secretary, Dr. C. H. Heacock, 20 S. Dunlap St., Memphis, Tenn.
Annual meeting: Richmond, Va., November, 1933.

Brooklyn Roentgen Ray Society
Secretary, Dr. G. W. Cramp, 921 President St., Brooklyn, N. Y.
Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y.
Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. R. G. Willy, 1138 N. Leavitt.
Meets second Thursday of each month October to May inclusive at the Palmer House.

Cincinnati Radiological Society
Secretary, Dr. H. G. Reineke, Christian R. Holmes Hospital, Cincinnati, Ohio. Meetings held monthly.

Cleveland Radiological Society
Secretary, Dr. Otto Glasser, Cleveland Clinic.
Meetings are held at 6:30 P.M. at the Cleveland Chamber of Commerce Club rooms on the fourth Monday of each month from October to April, inclusive.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital.
Meets monthly on first Thursday from October to May, at Wayne Country Medical Society Building.

Florida Radiological Society
Secretary, Dr. W. McL. Shaw, 418 St. James Bldg., Jacksonville, Fla.
Meetings held twice a year, May and November.

Illinois Radiological Society
Secretary, Dr. H. W. Grote, 219 N. Main St., Bloomington, Ill.
Regular meetings held quarterly.

Indiana Roentgen Society
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

Michigan Association of Roentgenologists
Secretary, Dr. S. W. Donaldson, St. Joseph's Mercy Hospital, Ann Arbor, Mich. Three meetings a year, Fall, Winter, and Spring. Next meeting, Kalamazoo, Mich., November, 1933.

Milwaukee Roentgen Ray Society
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee, Wis
Meets first Friday in October, December, February and April. Place of meeting designated by the president.

Minnesota Radiological Society
Secretary, Dr. L. G. Rigler, University Hospital, Minneapolis, Minn.

New England Roentgen Ray Society
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

New York Roentgen Society
Secretary, Dr. C. W. Schwartz, 33 E. 68th St., New York.
Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N.C.
Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. H. S. Bull, 604 Masonic Temple, Auburn, N. Y.
Three meetings a year—January, May and November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif.
Meets annually, during meeting of California Medical Association

Pennsylvania Radiological Society
Secretary, Dr. W. E. Reiley, Clearfield, Penna.

Philadelphia Roentgen Ray Society
Secretary, Dr. Karl Kornblum, Graduate Hospital.
Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. W. W. Fray, Strong Memorial Hospital.
Meets monthly on second Thursday from October to May, inclusive, at 7:45 at the Rochester Medical Association Building.

St. Louis Roentgen Club
Secretary, Dr. W. K. Mueller, University Club Bldg.
Meets first week of each month. Time and place of meetings designated by president.

South Carolina X-Ray Society
Secretary, Dr. R. B. Taft, 105 Rutledge Ave., Charleston.
Meets at time and place of South Carolina State Medical Association.

Texas Radiological Society
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

Meets annually one day preceding the meeting of the Texas State Medical Association.

University of Michigan Roentgen Ray Society
Secretary, Dr. C. C. Taylor, University Hospital, Ann Arbor, Mich.
Meets first and third Wednesday evening of the month from October to June, at 8 o'clock in the amphitheatre of the University Hospital.

University of Wisconsin Roentgen Club
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis.
Meets monthly on last Thursday, October to April, Service Memorial Institute, at 4:30 P. M.

Virginia Roentgen Ray Club
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.
Meets annually in October.

Cuba

Sociedad Cubana de Radiologia y Fisioterapia
Secretary, Dr. Luis Fariñas, Animas 110, Havana, Cuba.
Meets monthly in Havana.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

Electro-Therapeutic Section of the Royal Society of Medicine (Confined to Medical Members)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

Section of Radiology and Medical Electricity, Australasian Medical Congress
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

Radiological Section of the Victorian Branch of the British Medical Association
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

Section on Radiology, Canadian Medical Association
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

Indian Radiological Association
Secretary, Sd. Subodh Mitra, 148 Russa Rd., Calcutta.
Meets annually in January, and at such places and times as the Council may appoint.

Radiological Section, New Zealand British Medical Association
Secretary, Dr. P. C. Fenwick, The Hospital, Christchurch. Meets annually.

Continental Europe

Belgian Society of Roentgenology
Secretary, Dr. J. Boine, Avenue des Allies, 134, Louvain, (Belgian).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summer time.

Société de Radiologie Médicale de France
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Société Suisse de Radiologie (Schweizerische Röntgen-Gesellschaft)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

Société Francaise d'Electrothérapie et de Radiologie Médicale
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

Association of German Roentgenologists and Radiologists in Czecho-Slovakia
Secretary, Dr. Walter Altschul, German University, Prague, 11/52.

Deutsche Röntgen-Gesellschaft (Gesellschaft für Röntgenkunde und Strahlenforschung)
Meets annually in April in different German cities, at least once in five years in Berlin. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

Dutch Society of Electrology and Roentgenology
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

Societa Italiana Radiologia Medica
Secretary, Professor M. Ponzio, University of Turin, Turin.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banul Maracine 30, Bucarest, Rumania.
Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad, USSR, in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society.
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

Polish Society of Radiology
Secretary, Dr. Jan. Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summer time.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summer time.

Society of Medical Radiology of Sweden
Meets in Stockholm.

Society of Medical Radiology in Norway
Meets in Oslo.

Society of Medical Radiology in Denmark
Secretary, Dr. H. Scheuermann, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

Society of Medical Radiology in Finland
Meets in Helsingfors.

Vienna Society of Roentgenology
Meets first Tuesday each month, October to July.

Orient

Japan X-ray Association
c/o Orthopedic Surgery, Tokyo Imperial University.
Meets annually in April.

Kinki Roentgen-Abend Society
Director, Dr. Prof. Taiga Saito, Ogawaoike, Kyoto, Japan. Meets bi-monthly on third Sunday.

A CORRECTION

To the Editor:

In my paper on "The Pineal Body" published in the August, 1933, issue of the Journal, the following statement is made on page 148: "Schüller stated that the normal position of the pineal shadow in lateral roentgenograms of the skull was 1 cm. above a line joining the external auditory meatus and the lower border of the orbit, and 1 cm. posterior to the vertical plane, through the external auditory meatus."

This should be changed to read: ". . . 4.5 to 5 cm. above a line joining the external auditory meatus," etc.

J. H. VASTINE

MINNESOTA RADIOLOGICAL SOCIETY

The Minnesota Radiological Society held its Fall meeting at the St. Paul Athletic Club, St. Paul, Minnesota, November 11, 1933. The following program was presented: "Osteochondritis Juvenilis Deformans (Perthes' Disease); Report of Cases." W. L. Burnap, M.D., Fergus Falls; "Observations from a Clinical Tour." M. A. Shillington, M.D., St. Paul; "Pneumonia in Young Infants Associated with the Aspiration of Various Oils." Kano Ikeda, M.D., St. Paul; "The Roentgen Diagnosis of Placenta Praevia." Walter H. Ude, M.D., Minneapolis; "The Improvement of Chest Roentgenography." R. B. Wilsey, M.A., Rochester, N.Y.; "Motion Picture Demonstrating Manufacture of X-Ray Film." L. A. Carlson, St. Paul; "The American Registry of Radiological Technicians." George M. Landau, M.D., Chicago. Address: "The Value of Ventriculography and Encephalography to the Brain Surgeon" by Alfred W. Adson, M.D., Rochester, Minnesota.

UNIVERSITY OF WISCONSIN ROENTGEN CLUB

The University of Wisconsin Roentgen Club held its first meeting on Thursday, October 26, 1933. The following topics were discussed: "Lesions of the Cardio-esophageal Region" (Dr. L. W. Paul); "Extra-gastrointestinal Masses" (Dr. L. W. Paul), and "Radiation Therapy in Mediastinal Tumors" (Dr. E. A. Pohle).

Dr. C. R. Bardeen, Dean of the Medical School is Chairman of the Club and Dr. E. A. Pohle, Secretary. Meetings will be held on the last Thursday of each month from October to April.

Vol. XXX, No. 5

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., 105 Rutledge Ave., Charleston, S. C.

"CHIP-IN" METHOD OF TIME-TEMPERATURE TANK PROCESSING

By S. W. DONALDSON, M.D.
St. Joseph's Mercy Hospital
ANN ARBOR, MICHIGAN

SINCE the time-temperature tank development (5 min. at 65° F.) has been so successfully and universally employed in the x-ray processing room, an efficient method of estimating the rate of developer exhaustion has been needed.

Fig. 1.

An inexpensive and reasonably accurate method of recording and compensating for the degree of exhaustion of a developing solution for roentgen films has been successfully employed at St. Joseph's Mercy Hospital, Ann Arbor, Michigan, for over a year. The system was originally devised here and as far as we know is the only one now in use.

In our laboratory, the amount of work and number of films exposed vary seasonally. It is therefore difficult to set a definite day to make up new developing solution. Various known methods for determining the strength of solutions were tried from time to time but discontinued for one reason or another. For a considerable period of time before installing our present system, the films developed were tallied in order to obtain a general idea as to the number of each size of film used before solutions were discarded. Ten gallon tanks were filled and fresh solution was added from time to time in order to maintain the original required volume. One large dry film will take up and carry over to the wash water, unless well drained, about an ounce of solution.

It was found that 10 gallons of solution would handle:

100 ..... 14″ × 17″ films
120 ..... 8″ × 10″ films
60 ..... 10″ × 12″ films
60 ..... 11″ × 14″ films
60 ..... 6½″ × 8½″ films

and 300 regular size dental films or the equivalent in square inches of emulsified surface before complete exhaustion occurred or stain appeared, or approximately forty films per gallon. A simple counting system was then tried out and it has so far proved to be entirely successful.

For our counters 400 poker chips were obtained. In order to secure colors other

than the conventional red, white and blue, some blue and white chips were half submerged in red, quick-drying lacquer. This method made it possible for us to obtain five different sets of chips, as follows:

100 white chips, each representing a 14″×17″ film
120 half-red, half-white chips, each representing an 8″×10″ film
60 red chips, each representing a 10″×12″ film
60 blue chips, each representing a 11″×14″ film
60 half-red, half-blue chips, representing a 6½″×8½″ film

The chips were then stacked in a rack and placed near the film dryer. Each time a film is hung to dry, a poker chip of the color designating that size is removed from the stack and dropped through an opening into a container. A slot in the cover of an empty No. 4 can in which developing powders are packed serves our purpose well.

Sometimes it becomes necessary to use combinations of chips when all of one size is expended—that is—three 8″×10″ or two 10″×12″ or one 11″×14″ and one 8″×10″ are approximately equal to one 14″×17″ or other combinations to obtain an approximately equal number of square inches of surface. Dental films are "chipped-in" with a white chip when a gross package is opened as it is easier than to wait until they are all developed.

As the height of the stacks of chips grows less, we increase the developing time, which was originally five minutes at 65° F. When all the chips are used, the solutions are considered completely exhausted and new solutions are then made. The chips are then sorted and restacked in the respective troughs ready to be used for the next batch of developer.

The adjustment in time of development is easily controlled by having the back of the trough in which the various colored chips are stacked, divided by colors into three zones. The upper zone, or 60 per cent of the entire height, of the stack is labeled "five minutes," the middle, or 25 per cent, labeled "six minutes"; and, the lower part, or remaining 15 per cent, is the seven minute zone. When a new color level is reached in one stack, combinations are used to bring the other stacks down to the corresponding color level before the time is increased.

We have found that this method is exceedingly practical, surprisingly accurate and that it takes less time and trouble than any method we have tried.

INDEX TO ABSTRACTS

ROENTGEN DIAGNOSIS

Head

Rovida, Francesco: Schüller-Christian's disease 698

Agati, Dino: Infiltrating tuberculosis of the vault of the cranium 698

Geyman, M. J., and Clark, D. M.: The roentgen demonstration of petrositis 698

Renander, Axel: The roentgen picture in deep otogenous diseases of the petrous bone. Apicitis. Gradenigo's syndrome 699

Matteucci, Eugenio: Vogt's method 699

Solomon, H. C., and Epstein, S. H. Encephalography under narcosis produced by non-volatile anesthetics 699

Dunlap, H. E.: Metastatic malignant tumors of the brain 700

Scheuermann, H.: The roentgenological picture of the normal and the pathologic sella turcica 700

Neck and Chest

Delherm, Thoyer-Rozat, P., Codet, P.-H., and Fischold, H.: Kymography 701

Bogart, F. B: X-ray examination of the heart in left auricular enlargement 701

Blitch, C. G., Morgan, H. J., and Hillstrom, H. T.: Early (subclinical) syphilitic aortitis 701

Lupacciolu, G.: Two cases of aneurysm of the innominate artery 702

Beutel, A.: Varices of the esophagus 702

Laurell, Hugo: The origin of the Zenker pouch of the pharynx 702

Brachman, D. S.: Modern case-finding in tuberculosis 703

Steidl, John: Tuberculosis among medical students 703

Wolff, E., Stone, R. S., and Eberson, F.: Juvenile tuberculosis suspects 703

Fales, L. H.: A protest against the conception of arrest in pulmonary tuberculosis as outlined by the classification of the American Sanatorium Association 704

Accorimboni, Mario: Unusual roentgen appearance of pneumothorax complicated by adhesive pleurisy; paradoxical picture of the lung 704

Andrus, Paul M.: The interpretation of apical linear shadows in roentgenograms of the thorax 704

Maragliano, G.: The frequency of early infiltration 705

Torelli, G.: Cause of opaque or paradoxical pneumothorax 705

Ottonello, P.: Interlobar sclerosis of an accessory lower lobe 705

Vallebona, A.: A roentgen picture of the lung showing many intersecting rings 706

Ottonello, P.: The roentgen picture of the posterior pleural recess 706

Ottonello, P.: The roentgen picture of the lower accessory lobe of the lung 706

Dufault, Paul: Basal pulmonary lesions 707

Siciliano, L., and Banci-Buonamici, C.: The capillary line of the right lung 707

Ottonello, P.: Roentgen picture of the lower median edge of the lungs 707

Kjerp, G.: Pleural calcification 708

Scarinci, C.: Multiple fibrinous foreign bodies in the pleural cavity an unusual complication of therapeutic pneumothorax 708

Torelli, G.: An unusual picture in pneumothorax: opaque pneumothorax 708

Asti, L. M.: Osteogenetic lung metastases from osteosarcoma of the femur 708

Cooper, F. G.: The association of tuberculosis and carcinoma 708

Abdomen

Wagner, A.: Esophageal orifice hernia 709

Finsterbusch, R., and Gross, F.: The value of early roentgen demonstration of spontaneous pneumoperitoneum in perforated stomach ulcer and other diseases of the digestive tract 709

Jankelson, I. R.: Peptic ulcers in children ... 710

Lupacciolu, G.: A case of ulcer of the pylorus "vis-a-vis" 710

Anzilotti, A.: Final report on a case of pedunculated tumor of the stomach diagnosed roentgenologically and controlled by operation 710

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

HEAD

Rovida, Francesco. Della malattia di Schüller-Christian. (Schüller-Christian's disease.) *Radiol. med.*, July, 1932, *19*, 667–691.

A case of Schüller-Christian's disease, or hypophyseal dysostosis, is described in a child twenty-three months of age. The mother began to notice arrest of development at the age of eight months. In the spring of 1929 a soft swelling developed in the left temporo-parietal region and gradually increased in size. About six months later the child began to have a blackish discharge from the nose and ear. The Wassermann reaction was negative. After a reactivating injection of calomel it was positive for two antigens and negative for two. When the child was brought to the roentgen institute for examination he showed two swellings in the temporo-parietal regions, one the size of a walnut and the other the size of a large pigeon's egg, and other smaller ones on the frontal bone. The roentgen picture showed many clear areas in the bones of the skull, giving it a "geographic" appearance. The bones of the face were normal but there were areas of rarefaction in the humeri and one in the left wing of the ilium.

The case was evidently one of Schüller-Christian's disease. Differential diagnosis from neoplasm was made by histological examination of a piece of excised tissue. From February 11 to March 15, 1930, a series of roentgen treatments amounting to 700 r was given over the left temporo-parietal region and 345 r on the right side, in fractional doses of 70 r on alternate days; 160 kv. 3 ma., filtered with 0.5 mm. copper and 3 mm. aluminum, fields 10×10, focus-skin distance 36 cm. The child improved greatly and later the humeri and iliac bones were irradiated.

The author discusses the various theories in regard to the origin of the disease and concludes that the primary cause is not hypophyseal, though it shows the symptoms of lesions of the tuber cinereum and hypophysis. The areas of rarefaction in the bones are always present, but the other symptoms of the disease, diabetes insipidus, exophthalmos and retardation of growth may be absent or develop late. Spontaneous cure may occur, particularly if the disease develops late in life.

The disease is really a xanthomatosis caused by disturbances of fat metabolism, and the hypophyseal involvement is secondary. The best treatment is roentgen irradiation. Hard rays are generally used with a dose varying from a third to a half of an erythema dose. A moderate dose should be given at first and the results followed up by roentgen examination, the later doses being adapted to the findings.—*Audrey G. Morgan.*

Agati, Dino. Tubercolosi infiltrante della volta cranica. (Infiltrating tuberculosis of the vault of the cranium.) *Radiol. med.*, May, 1932, *19*, 476–482.

The circumscribed, perforating form of chronic tuberculosis of the skull is more common than the progressive infiltrating form. The author describes a case of the latter in a patient sixteen years of age in which the roentgen picture of the skull was not decisive enough for a definite diagnosis. In this case the differential diagnosis had to be made from hypophyseal dysostosis, myeloma or chloroma rather than from syphilis, echinococcus or neoplasm, and the differentiation from these conditions is discussed. Diagnosis was possible only from careful study of both the clinical and roentgen signs. The frontal bones showed zones of transparency. These clear zones had indistinct and slightly dentate outlines without any density around the margins indicating bone or periosteal reaction; in their centers were small shadows probably caused by small sequestra. The sella turcica was normal in size and shape. —*Audrey G. Morgan.*

Geyman, Milton J., and Clark, Daniel M. The roentgen demonstration of petrositis. *Acta radiol.*, May 15, 1932, *13*, 125–133.

There has been no adequate standardized technique for the roentgen demonstration of suppuration in the petrous portion of the temporal bone. As in the mastoid process, the cell development of the petrous portion varies greatly within normal limits and it is necessary to

have a thorough understanding of its cell development in order to be able to interpret the roentgenograms correctly. As a general rule, the petrous pyramid shows a cell development parallel with that of the mastoid; that is, if the mastoid is sclerotic the petrous pyramid will be and if the mastoid is pneumatized the petrous bone will be also. Infection nearly always occurs in the pneumatized type of bone. There seem to be two chief paths by which infection spreads from the tympanum to the tip of the petrous bone—the antrum-epitympanic route and the hypotympanic route.

The authors show that the positions used in the study of the petrous bone for 8th nerve tumors are not at all satisfactory for the demonstration of petrositis. The vertico-mental and fronto-occipital positions give the best results. In the case of infection by the hypotympanic route the infection may not show in the fronto-occipital view, but infections along the antrum-epitympanic route may be shown in either position. As the pathological process is similar to that in the mastoid the roentgen picture is similar. At first there is simply a general haziness and displacement of air as compared with the normal side; later there may be destruction of cell outline and localized abscess formation and finally healing with sclerosis throughout the involved area.

A diagnosis of petrositis should never be made without clinical symptoms. Asymmetrical mastoid development is very frequent and the same thing probably occurs in the petrous pyramids. One pyramid may be sclerotic and the other pneumatized. When sclerotic pyramids are demonstrated on both sides petrositis is not probable. Bilateral petrositis has never been reported.—*Audrey G. Morgan.*

Renander, Axel. Das Röntgenbild bei otogenen tiefen Felsenbein Affektionen. Apizitis. Gradenigos syndrom. (The roentgen picture in deep otogenous diseases of the petrous bone. Apicitis. Gradenigo's syndrome.) *Acta radiol.*, May 15, 1932, *13*, 165–177.

The author describes 5 cases of Gradenigo's syndrome which he examined roentgenologically. All of them showed changes in the roentgen picture, which in 4 of the cases were very marked, in the other one less so. The roentgen picture generally showed a diffuse thinning of the bone at the tip of the pyramid, interruptions of continuity of the outline of the cortex and defects in the tip of the pyramid. The defects at the apex were probably caused by halisteresis.

Special care has to be exercised in taking pictures of this region. The author has found Stenvers' position the best as it gives a picture of the apex in natural proportion without any disturbance from superposition of other bone shadows. The disadvantage of this position is that it is hard to carry out accurately and requires a little practice. A primary diaphragm should be used and stereoroentgenograms taken.—*Audrey G. Morgan.*

Matteucci, Eugenio. Sul metodo Vogt. (Vogt's method.) *Radiol. med.*, May, 1932, *19*, 482–485.

In 1921 Vogt described a method of demonstrating foreign bodies in the eye which are too small or of too low an atomic weight to be shown by the ordinary methods of roentgen examination. These bodies are often hidden by the shadow of the bones in the ordinary methods of examination but by this method no bone shadows are taken. A small film is held at the inner angle of the eye parallel to the inner wall of the orbit and the roentgenogram taken from the temporal side or the film is held horizontally parallel to the floor of the orbit and the roentgenogram taken from above. A small fishhook is hooked into the conjunctiva under local anesthesia to act as a guiding point to localize the foreign body. A tube with a punctate focus is used and the rays, filtered through 1 mm. aluminum, pass through a cylindrical limitator 30 cm. long and 6 cm. in diameter. The focus-skin distance is 60 cm., intensity 35 ma., tension 40 kv.

The author describes 2 cases in which small bodies in the anterior part of the eye were located in this way and the patients saved enucleation. One of the foreign bodies was removed with a magnet and the other extracted with small forceps.—*Audrey G. Morgan.*

Solomon, H. C., and Epstein, S. H. Encephalography under narcosis produced by nonvolatile anesthetics. *J. Am. M. Ass.*, May 21, 1932, *98*, 1794–1796.

Although encephalography is largely replacing ventriculography, the extreme headache, nausea, vomiting, diaphoresis and even collapse, often met with render it an unpleasant and tedious proceeding. Morphine and scopolamine fail to completely control symptoms;

ether is attended with the hazard of pulmonary complications and produces an undesirable rise in blood pressure. Non-volatile anesthetics such as pentobarbital sodium, amytal, and avertin have been used with much success. The authors use the first named and have produced a deep anesthesia, obviating symptoms and producing no harmful effects. Headache may occur five or six hours later but is mild and easily controlled. The authors describe a special chair stretcher with movable back rest, shoulder straps and a head sling. This permits easy handling of the anesthetized patient with rotation of the head in all positions to obtain necessary encephalograms.—*E. W. Hall.*

Dunlap, Harold F. Metastatic malignant tumors of the brain. *Ann. Int. Med.*, April, 1932, *5*, 1274–1288.

This is a clinical, statistical and pathological survey of 95 patients with a diagnosis of metastatic malignant tumor of the brain. The average age was 47½ years; 49 males and 46 females. In cases in which the primary lesion should have been readily recognized, the average duration prior to the onset of cerebral symptoms was 21 to 31.5 months. The average length of life from the time of examination after onset of cerebral symptoms was 3½ months.

The presenting symptoms were directly referable to the cerebral lesion in 68 cases, to the primary lesion in 15, while 12 cases presented symptoms referable to both lesions. The most frequent cerebral symptoms were headache, vomiting, often of a projectile nature, disturbances of vision and of speech, vertigo and transient aphasia. Mental disturbances appear to be one of the outstanding features as they were observed in 57 per cent of the series, varying from sluggishness to confusion and even stupor in the more advanced cases. The presence and severity of mental symptoms appeared to bear a possible relationship to the presence and severity of the encephalitic changes. Those symptoms associated with metastatic tumor of the brain seemed to be more marked than those associated with primary brain tumor. Choked disk was found in 40 per cent of 84 cases so examined; 9 cases presented perimetric visual field defects and 3 showed optic atrophy.

Study of the clinical localization of the cerebral tumors failed to disclose any region of predilection for the development of metastasis in the brain. Detailed neurological study was carried out in 16 cases and the site of the cerebral lesion correctly diagnosed in 7 of these. In the remaining 9 cases either localizing signs were absent or dissemination of the signs led to incorrect diagnosis of an inflammatory lesion. Metastatic malignant tumor of the brain was diagnosed in 6 cases, there being an obvious primary tumor elsewhere than the brain, recognizable metastasis or a history of previous operation for a malignant tumor situated outside of the central nervous system in all. A diagnosis of primary tumor of the brain was made in 5 cases, none of which presented either symptoms or signs referable to a primary lesion elsewhere.

Roentgenologic study failed to reveal the presence of many of the growths encountered. A diagnosis of primary or metastatic malignant growth of the lung was made in 37 per cent of the 78 cases examined. Metastasis or other pathologic change was reported in 21 per cent of the 63 cases in which roentgen examination of the skull had been made.

The lung, breast and kidney accounted for 58.6 per cent of the primary lesions in those cases where the site could be determined. Metastasis was widespread throughout the body in general, the lung being involved in 83 per cent of those cases in which necropsy was performed.

All cases presenting clinical evidence of a tumor of the brain should be studied carefully for presence of primary malignant tumor outside of the central nervous system. Roentgenograms of the thorax and skull, for evidence of metastasis, should be made as a routine in such cases.—*W. R. Brooksher, Jr.*

Scheuermann, H. The roentgenological picture of the normal and the pathologic sella turcica. *Acta radiol.*, 1932, *13*, 404–432.

The author has collected and examined roentgenograms of the skulls of 391 patients showing normal conditions and 55 with diseases of the brain showing roentgen changes. Specimens of the sella turcica from 100 patients with normal conditions and 41 with brain affections have been examined roentgenologically, compared, sawed through and then compared again. The technique of roentgen examination of the skull is discussed and the necessity for absolutely exact and uniform projection emphasized. The normal anatomy of the sella turcica is described.

The roentgen picture of the sella is described

in detail, giving measurements and form and descriptions of the sphenoidal sinus, the anterior clinoid processes, the dorsum sellae and the posterior clinoid processes. The dorsum sellae may normally be so thin as to be invisible in the roentgenogram of the living subject. A thin dorsum sellae is the most frequent form. The tissue may, even under normal conditions, be so plastic that the dorsum sellae can be moved forward and backward with the hand. The large air space in the spongy dorsum sellae is described and the characteristics of the dura mater and its calcareous content discussed. There may be a deficiency of calcareous material in the dorsum sellae at any age; it is not caused by senile osteoporosis.

The position of the head in certain brain tumors and the basal angle are discussed. Differences in the width of the latter are not important.

The causes of primary and secondary enlargement of the sella are discussed. Dilatation of the third ventricle for a considerable time may cause enlargement of the sella; dilatation of the ventricle for a short time does not have any effect.

In all the cases examined, the autopsy findings agreed with the roentgen findings. The roentgenologist should be very reserved in expressing an opinion as to whether pathological changes in the sella are primary or secondary.—*Audrey G. Morgan.*

NECK AND CHEST

Delherm, Thoyer-Rozat, P., Codet, P.-H., and Fischold, H. La kymographie. (Kymography.) *Presse méd.*, April 2, 1932, *40*, 515–517.

The kymography of the heart introduced by Stumpf is very simple, representing a method analogous to serial roentgenography for the study of the duodenal bulb. It consists in the use of a lead diaphragm having parallel slits of 0.5 mm. width at intervals of 11.5 mm. from each other which is interposed between the subject and the film during the time of exposure. To record the movements one may displace either the film or the diaphragm for a distance corresponding to a single interval between the two slits. The two procedures lead to somewhat different results. In the first (displacement of the film) the motion of a limited number of points of the heart silhouette is recorded, the image thus taking the aspect of steps of a scale. In the second (displacement of the diaphragm) the motion of the entire heart silhouette is registered, the contours assuming a finely dentated aspect on the films. The two methods have an equal value, except that the first permits the reconstruction of the movements by a very simple procedure with the aid of the kymoscope. The second is used chiefly in the current practice.

The kymogram represents a succession of sinuosities and notches replacing the usual contours of the heart and aorta. By studying the number, amplitude, peristalsis, density, form, etc., of these sinuosities and notches, one may arrive at a definite conclusion concerning the changes of various sections of the heart. The authors briefly describe the appearance in normal and in pathologic conditions, such as valvular lesions, affections of the pericardium and of the great vessel.

The conclusion is reached that kymography, although still in the stage of development, represents certain indisputable advantages. Thus the clinician is able to obtain the record of the diastole and systole on the same film, he may precisely determine the location of point G, he may differentiate between the left auricle, pulmonary artery and aorta and finally he may establish a differential diagnosis of certain mediastinal opacities.—*T. Leucutia.*

Bogart, Franklin B. X-ray examination of the heart in left auricular enlargement. *South. M. J.*, June, 1932, *25*, 596–602.

Roentgen examination of the heart in left auricular enlargement by roentgenoscopy with either the teleroentgenogram or orthodiagram gives information that is of value in diagnosis and prognosis. The methods of examination are detailed with the normal findings briefly reviewed. Left ventricular enlargement produces changes on the contour of the heart, bronchi and esophagus. The use of lipiodol and barium for the visualization of the left bronchus and the esophagus respectively is discussed. The article is illustrated with films and diagrams.—*W. R. Brooksher, Jr.*

Blitch, C. G., Morgan, Hugh J., and Hillstrom, H. T. Early (subclinical) syphilitic aortitis; an evaluation of radiographic diagnostic methods. *South. M. J.*, July, 1932, *25*, 709–711.

If aortitis could be detected before the development of irreversible changes therapeutic

results would be markedly improved. Such "subclinical" aortitis might be arrested and the development of the late, fatal manifestations prevented. The present study was confined to individuals with uncomplicated chronic syphilis without clinical evidence of aortitis, but in whom the incidence of subclinical aortitis is doubtless high. In such patients any deviation from the normal aortic roentgen findings would be significant and would constitute presumptive evidence of aortitis. There were 30 such cases available for study, all males, with an age range of thirty-five to fifty-five years. Roentgenoscopic and film studies in all projections and the ingestion of thick barium paste to determine the relationship of the esophagus, heart and aorta, were carried out in all cases. The usual cardiac measurements were made. The diameter of the aortic arch was measured at the point where the aorta indents the visualized esophagus. The studies were entirely negative in that no changes were found which are not encountered in perfectly normal individuals of the same age group.—*W. R. Brooksher, Jr.*

LUPACCIOLU, GIOVANNI. Due casi di aneurisma dell'arteria anonima. (Two cases of aneurysm of the innominate artery.) *Radiol. med.*, Feb., 1932, *19*, 122–130.

Aneurysm of the innominate artery is quite rare. The author describes 2 cases with illustrative roentgenograms. The first was in a man of thirty-eight in whom a diagnosis of asthma was made at first because of expiratory dyspnea. He complained of constant dizziness. The Wassermann and Meinicke reactions were negative. Roentgen examination showed a shadow that extended from the mediastinum over the whole upper median third of the right lung field. In the oblique projection it was dissociated from the shadow of the large vessels and showed expansive pulsation. On the basis of this picture a diagnosis of aneurysm of the innominate artery was made; it was confirmed by death of the patient from rupture of the aneurysm.

The second case was in a man of thirty-nine with a history of syphilis. On the basis of the shadow in the mediastinum a diagnosis of tumor of the mediastinum was made and roentgen treatment given. This did no good at all but the patient improved considerably on antisyphilitic treatment. This patient also complained of dizziness; he had a feeling of constriction in the throat and pain irradiating from the neck to the right arm; he spoke in a low voice and had a feeling of formication in the right hand which was somewhat cyanotic. From the failure of roentgen therapy it was decided that the diagnosis was wrong and the patient was sent for another roentgen examination with a probable diagnosis of aneurysm of the aorta. The picture was very much like that in the preceding case, except that the dense shadow did not pulsate. A diagnosis of aneurysm of the innominate was made and in this case was also confirmed later by death of the patient from rupture of the aneurysm.

Patients with aneurysm of the innominate almost always complain of dizziness. This in association with a shadow in the right upper half of the mediastinum should suggest aneurysm of the innominate. The shadow does not necessarily pulsate. Cardarelli says the dizziness and fainting fits are due to cerebral aneurysm from bits of clot detached from a thrombosis but the author thinks it more probable that the sac brings about disturbances in the circulation of the internal carotid which cause these symptoms.—*Audrey G. Morgan.*

BEUTEL, A. Oesophagusvarizen. (Varices of the esophagus.) *Acta radiol.*, 1932, *13*, 527–532.

Two cases of varices of the esophagus are described and illustrated with roentgenograms. Both the patients showed the clinical picture of cirrhosis of the liver. The diagnosis of varices of the esophagus was made from the roentgen picture and confirmed in both cases by esophagoscopy and in one by autopsy also.

Normally the relief of the esophagus is characterized by delicate longitudinal folds. These disappear in varices. The esophagus is abnormally wide and there are clear bands, which may run longitudinally or transversely, bordered by narrow stripes of contrast medium. The barium sticks to the dilated vessels and remains in the esophagus an abnormally long time. Differential diagnosis from malignant tumor is sometimes difficult. Normal distensibility of the wall of the esophagus does not always exclude tumor. The roentgen diagnosis of varices of the esophagus is of great value in explaining obscure cases of hematemesis.—*Audrey G. Morgan.*

LAURELL, HUGO. The origin of the Zenker pouch of the pharynx. *Acta radiol.*, 1932, *13*, 599–602.

In a previous article in this journal the author discussed the origin of Zenker's pouch and

the mechanism of swallowing. Barclay in a later number criticized Laurell's conclusions and held that these diverticula are caused by traction from adhesions and not by pulsion. In this article Laurell replies to Barclay's arguments and reaffirms his opinion that these diverticula are caused by pulsion.—*Audrey G. Morgan.*

Brachman, D. S. Modern case-finding in tuberculosis. *Am. Rev. Tuberc.*, July, 1932, *26*, 89–97.

Modern tuberculosis case-finding calls for tuberculin testing of all children and adolescents, with the reactors receiving roentgen-ray examinations. With positive or suspicious roentgen findings a complete history and physical examination are advisable. This method results in early diagnosis, making it easy to secure cures by modern therapy. A negative diagnosis should not be made without a corroborating negative roentgen report. The present study was carried out in three Detroit high schools, the tuberculin (Pirquet) test being completed on 3,719 students, or 66 per cent of the total enrollment; 1,629 roentgen examinations were made in the positive reacting casts. The roentgen ray is considered the most important step of the case-finding program but it definitely is not complete in itself. The excessively high death rate from tuberculosis among the colored population of Detroit was found to correlate with the reactions in the higher ages, but in the lower ages, five to fourteen, the percentage was but slightly higher than in white children, 23 per cent compared with 20 per cent. The study demonstrated an incidence of 0.6 per cent with adult type, 4.9 per cent childhood and 1 per cent suspects, all cases being considered favorable for treatment. —*W. R. Brooksher, Jr.*

Steidl, John. Tuberculosis among medical students. *Am. Rev. Tuberc.*, July, 1932, *26*, 98–103.

This is a comparative study of the incidence of pulmonary tuberculosis among law and medical students by the questionnaire method. Students of the respective schools graduating in the years 1921–1929 were queried as to (1) whether or not they had developed tuberculosis, (2) the criteria of diagnosis and (3) the time of development, whether during school years or later. There was approximately a 50 per cent return of the questionnaires from both groups. Of the medical students, 14 or 2.5 per cent developed the disease, of which 6 cases were developed during school years and 7 shortly after graduation. Twelve law students were affected, or 2.08 per cent with only 2 cases developing during school years and the rest occurring in from one to ten years after graduation. The diagnostic criteria were considered adequate in all cases, there being but one case in which a chest roentgen examination was not made and this one presented positive sputum findings. It is possibly significant that only 2 of the law students developed the disease during school years, while nearly half of the medical students affected showed the disease in the same years. The author concludes that in order to make a diagnosis at a time when the disease is most amenable to treatment, all students, including the apparently healthy, should receive a proper stereoscopic roentgen examination of the chest with their general physical examination. The roentgen ray is considered the best single means of early diagnosis. —*W. R. Brooksher, Jr.*

Wolff, Ernst, Stone, Robert S., and Eberson, Frederick. Juvenile tuberculosis suspects. *Am. Rev. Tuberc.*, June, 1932, *25*, 738–745.

The different factors in the diagnosis of juvenile tuberculosis with special reference to roentgen findings and the various grades of intensity of the tuberculin reaction were studied in approximately 100 tuberculin-negative and 200 tuberculin-positive children, who were ambulatory and had no marked symptoms. The average ages were 8½ and 9 years respectively. All were suspected of having a tuberculous process or they had been exposed to tuberculosis. The symptoms and clinical findings were found to be of no value by themselves in making a diagnosis. The roentgenograms of the tuberculin-negative group were compared with those of clinically normal, tuberculin-negative children with an average age of 3½ years. The presence of single or multiple, large or small axial vessels in the hila or lungs, the presence or absence of increased linear markings with or without studding, or any localized pleural thickenings had no demonstrable significance in the tuberculin-negative group. No calcification, fibrotic spot, lymph node tumor or localized pulmonary infiltration shadow was found. A relatively high proportion of the non-tuber-

culous cases presented an increase in the linear markings in the upper lobes and the sign is apparently of little or no diagnostic value.

In the tuberculin-positive group, 42 per cent showed findings which were not present in the tuberculin-negative group, and which are, therefore, diagnostic. These were: hilus calcification, 14.8 per cent; hilus tumors, 6.6 per cent; lung fibrosis, 9.2 per cent; lung calcification, 13.3 per cent; lung infiltration, 9.7 per cent; pleural calcification, 1 per cent, and cervical lymph node calcification, 3 per cent. It was found that the percentage of these positive findings increased with the grade of the tuberculin reaction.—*W. R. Brooksher, Jr.*

Fales, Louis H. A protest against the conception of arrest in pulmonary tuberculosis as outlined by the classification of the American Sanatorium Association. *Am. Rev. Tuberc.*, May, 1932, *25*, 591–601.

The author discusses the ambiguity of the present classification and concept of arrest in pulmonary tuberculosis in relation to the advancement of knowledge of the disease in the past ten years. In proposing a new classification and concept of arrest, an arrested case and a healed lesion are considered synonymous; and an anatomical rather than a symptomatic arrest is the basis outlined. Constitutional symptoms due to tuberculosis are to be considered an expression of activity, but, arising from other causes, should receive but slight consideration. Physical findings have no place in the determination of an arrest. The roentgen examination is considered the main reliance in determining an arrest or healed lesion. When, by comparison of serial roentgenograms at quarterly intervals, a lesion is found hard and fibrosed, and has remained stable for six months, it is considered that an arrest has been attained, provided an additional six months of carefully graduated exercise and observation is passed without reactivation of the disease. It is highly essential that a future schema of classification should take into consideration the type of tuberculosis present and not merely the extent of the lesion, since in this manner will a common nomenclature be afforded the clinician, roentgenologist and pathologist.—*W. R. Brooksher, Jr.*

Accorimboni, Mario. Aspetto radiologico particolare del pneumotorace complicato da pleurite adesiva; l'immagine paradossa del polmone. (Unusual roentgen appearance of pneumothorax complicated by adhesive pleurisy; paradoxical picture of the lung.) *Radiol. med.*, Feb., 1932, *19*, 130–155.

Eight cases are described and illustrated with roentgenograms in which the picture was paradoxical; that is, instead of the shadow of the collapsed lung being dark and the air space being clear the shadow over the air space was darker than that of the lung. The author thinks this was caused by a serofibrinous pleurisy. The diffuse veil over the air space was due to a deposit of fibrin stratified over the wall of the pneumothorax cavity which stopped at the inner part of the wall over the collapsed lung because the lung was adherent to the wall and the two folds of the pleura were adherent to each other. This paradoxical picture in pneumothorax therefore is a definite indication of adhesion of a part of the lung to the wall of the thorax as a result of adhesive pleurisy.—*Audrey G. Morgan.*

Andrus, Paul M. The interpretation of apical linear shadows in roentgenograms of the thorax. *Am. Rev. Tuberc.*, Jan., 1932, *25*, 89–98.

Linear apical shadows in roentgenograms of the thorax have been described as "pleural caps." These are linear opacities in the 1st or 2nd interspace on one or both sides. The visceral margin is usually sharply defined but may become irregular from projections into the lung field and these may develop into parenchymatous tuberculosis. Those originally describing the condition felt that the appearance represented a progress of tuberculous infection from the pleura into the lung. The present author questions this explanation for all cases. He found that when lungs showing sharply defined pleural caps were collapsed for therapy the cap did not follow the lung but retained its original characters and position in relation to the bony cage. This suggested a parietal origin. In cases of opacities having irregular visceral margins, however, the shadow did not persist in its original position. In 30 per cent of cases of collapse, the cap was observed in its original location. Films taken before collapse of those cases showing the cap after pneumothorax had been instituted showed that in 53 per cent the identical shadow was present. In the remaining cases the cap was not seen before collapse, the area being obscured by parenchymatous de-

posits. Conversely, in no case was the cap seen before collapse and not visible in the pneumothorax films. The type of shadow which persists after collapse occurs within the arc of the first rib and in the posterolateral quadrant of the apical cupola. Its direction is forward and outward. The visceral margin is sharply defined and the density is homogeneous. The shadow never crosses the first rib. It ranges from 2 to 4 mm. in width and from 1.5 to 2 cm. in length. This shadow is thought by the author not to be due to thickened pleura but probably to Sibson's fascia which is a fibrous aponeurosis passing from the anterior surface of the transverse process of the 7th cervical vertebra to the inner margin of the 1st rib in front of the subclavian groove. Whatever the source of the shadow, it is stressed that it has no pathologic significance.

Apical pulmonary scars, on the other hand, are never sharply defined. Microscopically they consist of pleural and subpleural fibroses in which tubercles may or may not be frankly present. All such deposits are presumed to be of tuberculous origin. Any apical linear shadow that does not clearly conform to the position and characters of the so-called apical cap is probably of this nature. In 1,083 stereoscopic roentgenograms tuberculous scars were found in 27 per cent and apical caps in 34 per cent.

A further type of linear apical shadow is that seen beneath the 3rd (occasionally 2nd) posterior rib practically always on the left side only. A vertical continuation often passes to the aortic arch medially. This shadow is homogeneous. It is presumed to be due to the subclavian artery.—*G. R. Miller.*

Maragliano, Giulio. Sulla frequenza dell' infiltrato precoce. (The frequency of early infiltration.) *Radiol. med.*, June, 1932, *19*, 578–601.

The author discusses Assmann's theory of early infiltration as the first manifestation of adult tuberculosis as opposed to the old theory of the apical origin of the disease. In the examination of 3,200 roentgenograms he found the classical picture of early infiltration without involvement of the apices in only 15 cases. When rather less strict criteria were used the number of cases rose to 500. He concludes therefore that early infiltration is relatively rare and early infiltration without involvement of the apices still rarer. Assmann and his school would argue that these early infiltrations are transitory and therefore would not be revealed by roentgen examination unless it were made just at the right time. The author describes 6 cases illustrated with roentgenograms which show that they may persist for some months or a year. While this is not an extremely long time it is longer than the advocates of the early infiltration theory give to the demonstration of their theory. They base their demonstration on roentgenograms showing integrity of the apices and the rest of the lung and roentgenograms taken shortly afterward showing infiltration. They think that this proves that the infiltration is really the first manifestation of the reinfection. But this presupposes that once apical lesions have developed they persist throughout life. This is not true. The author describes a case in which roentgenograms taken in November, 1929, and April, 1930, showed the apices normal. A roentgenogram in August, 1930, showed subclavicular foci on both sides with the apices still clear. But an old roentgenogram from September, 1929, showed a small lesion in the left apex. Besides lesions of the apex are not always shown in roentgenograms.

The author concludes that the truth of the early infiltration theory is not proved. Assmann and his school say that the prognosis in these early infiltration cases is very bad if diagnosis is not made early and treatment given. The fear of overlooking such serious lesions may have caused roentgenologists to detect more early infiltrations than really existed.—*Audrey G. Morgan.*

Torelli, Gastone. Ulteriori considerazioni sulla genesi del pneumotorace apaco o pneumotorace ad immagine paradossa. (Cause of opaque or paradoxical pneumothorax.) *Radiol. med.*, Sept., 1932, *19*, 990–995.

The author describes 2 cases of pneumothorax which at first presented the normal picture of a light air space and a darker area corresponding to the collapsed lung. But in roentgenograms taken later the shadow of the air space was darker than that of the collapsed lung. This was due to the fact that the parietal pleura of the air space was thickened while a lobe of lung, adherent to the posterior wall of the thorax, had kept the pleura over the collapsed lung from becoming thickened.—*Audrey G. Morgan.*

Ottonello, Pietro. Sclerosi interlobare del lobo inferior accessorio. (Interlobar sclerosis

of an accessory lower lobe.) *Radiol. med.*, Aug., 1932, *19*, 821–825.

A child six years of age had had bronchitis and bronchopneumonia at the age of three, followed by bronchial catarrh and a cough which had persisted up until the present time. Clinically there was tracheobronchial adenopathy and occasionally fever. Roentgen examination showed a triangular opacity on the left side, which was not uniform but made up of rounded opaque areas separated by clearer regions. A little outside of this opacity and parallel with its lateral border there was a slender, intensely opaque line beginning at the level of the 6th rib and running obliquely downward and outward till it ended at the left costodiaphragmatic sinus. The lower half of the stripe was heavier than the upper part. It was evidently a thickened interlobe separating the left lower lobe from a supernumerary lobe. Such a lobe has often been found both on the right and left sides and is called an accessory lower lobe. The triangular shadow was evidently caused by lesions in the parenchyma of this accessory lobe.—*Audrey G. Morgan.*

Vallebona, Alessandro. L'imagine radiologica polmonare a cerchi multipli interfernti. (A roentgen picture of the lung showing many intersecting rings.) *Radiol. med.*, March, 1932, *19*, 308–327.

The author describes a roentgen picture of the lungs characterized by many circles which intersect or are superimposed on each other. In some cases the circles are flattened against each other making polygonal figures; these make a network with meshes of various sizes. This picture may cover the whole lung or a large part of it or only a small area. The boundaries of these circles or polygons are very fine lines, about like a "capillary stripe," and like the latter they can only be demonstrated by modern methods of roentgen examination. Four cases of this kind are described and illustrated with roentgenograms. In some cases the pictures look like a sacculated pneumothorax. This is evidently a picture of polycystic lung. It may be caused by bullous vesicular emphysema or by bronchiectasis, particularly the congenital form.—*Audrey G. Morgan.*

Ottonello, Pietro. La rappresentazione radiografica dello sfondato pleurico posteriore. (The roentgen picture of the posterior pleural recess.) *Radiol. med.*, May, 1932, *19*, 469–476.

The so-called posterior pleural recess or sinus is the angle formed where the costal pleura reflects into the diaphragmatic pleura. It is not shown in ordinary roentgen examination because in the sagittal projection it is masked by the liver shadow on the right and the stomach and splenic flexure on the left. The best way to examine it is in the dorso-ventral direction with the patient lying prone. It is a transparent space, grossly oval in shape with its long axis running horizontally. Its upper boundary is formed by the cupola of the diaphragm, its lower boundary by a curved line concave upward, which begins laterally at the wall of the thorax at the level of the lateral costo-diaphragmatic sinus and ends medially near the lateral margin of the first lumbar vertebra; there it turns suddenly upward and is prolonged upward for several vertebrae. It can be shown on both sides. The horizontal part of this line corresponds to the posterior costo-diaphragmatic pleural sinus and the vertical part of it to the posterior costo-mediastinal sinus. It is of value in making a new part of the pleura and lung accessible to roentgen examination.—*Audrey G. Morgan.*

Ottonello, Pietro. La rappresentazione radiografica del lobo polmonare inferiore accessorio. (The roentgen picture of the lower accessory lobe of the lung.) *Radiol. med.*, April, 1932, *19*, 390–400.

The author discusses the anatomy of the inferior accessory lobe of the lung, which is not so rare as is generally believed. It is analogous with the infracardiac lobe of quadrupeds. Ettig and Gräberger have described pathological cases which showed triangular basal paramediastinal shadows. The author gives a description of the normal appearance of the lobe on the right side in the roentgenogram of the thorax. The typical finding is a distinct thin opaque stripe representing the interlobular fissure which separates the lower lobe from the accessory lobe. It starts from the vertex of the cupola of the right diaphragm and runs upward and toward the midline in a line that is straight or slightly curved with the convexity outward until it passes into the shadow of the hilus. This stripe is due to the same cause as the capillary stripe of the middle lung field on the right which is caused by the middle interlobular fissure,

and its roentgen characteristics are also just the same. It is easy to differentiate it, however, from the other structures in the region. The author does not discuss the demonstration of such a lobe on the left side under normal conditions, not because it does not occur as often on the left as on the right but because the capillary stripe which bounds it is hidden in the heart shadow. He discusses the importance of recognizing this lobe, particularly when pathological changes take place in it, and the differential diagnosis of triangular basal paramediastinal shadows.—*Audrey G. Morgan.*

Dufault, Paul. Basal pulmonary lesions. *Am. Rev. Tuberc.*, Jan., 1932, *25*, 17–23.

To rule out pulmonary tuberculosis is a difficult problem in the diagnosis of chest diseases. Basal lesions present considerable difficulty in this field. Review of the literature indicates that basal tuberculosis is extremely rare. Pulmonary tuberculosis is almost never found exclusively in the lower lobe except when this lesion accompanies tuberculosis elsewhere in the body. At the Rutland State Sanatorium in Massachusetts only one case of strictly basal tuberculosis was found in two years.

Many basal lesions of non-tuberculous character have been admitted to the Sanatorium during this time with an incorrect diagnosis of tuberculosis. Five cases are presented, 3 of lung abscess and 2 of bronchiectasis. The conclusive diagnosis was made possible by bronchoscopy and lipiodol injection. The use of the bronchoscope is considered of great value in the differential diagnosis of basal lesions.—*G. R. Miller.*

Siciliano, L., and Banci-Buonamici, C. La linea capillare del polmone destra. (The capillary line of the right lung.) *Radiol. med.*, June, 1932, *19*, 571–577.

The so-called capillary line in the upper part of the right lung is generally admitted to be the shadow of the lesser incisure between the upper and middle lobes of the lung. But there is still a difference of opinion as to whether it can be seen in normal lungs or only in those in which the pleura is thickened by inflammation. Vespignani and Lenarduzzi, among others, claim that it can be seen in normal lungs if the right projection is used. They found it in 18 out of 20 individuals with normal lungs. They centered the rays on the 7th cervical vertebra, giving a projection very oblique from above downward.

The authors argue that the incidence of the rays would be very important if the surface of the interlobe were a plane. Then if the incidence of the rays were exactly parallel to its course it would give a shadow. But the surface of the interlobe is curved anteroposteriorly as well as transversely; therefore the incisure cannot give an exactly linear shadow no matter in what direction the rays strike it. From experiments in which he covered the upper surface of the middle lobe with silver foil, reinserted the lungs in the thorax and took roentgen pictures, and others in which he adapted thin layers of silver foil to curved surfaces of sugar or paper and made roentgenograms, the author concludes that the capillary line represents a certain part of the incisure. The flatter the curve, the more of it can be struck tangentially by the rays and the greater the opacity of the shadow. But the pleura has to have a certain thickness to give any shadow at all and only pleurae that have been thickened by inflammation give such shadows. The authors who have reported large percentages of positive results must have been working with pathological material. Galifi found only 4.38 per cent positive results in children, who are apt to have normal pleurae.—*Audrey G. Morgan.*

Ottonello, Pietro. La rappresentazione radiografica del margine infero-mediale dei polmoni. (Roentgen picture of the lower median edge of the lungs.) *Radiol. med.*, July, 1932, *19*, 704–707.

The lateral projection is not as much used as it should be in examination of the lungs and for this reason the picture described by the author has never been noted before. In normal cases when a lateral roentgenogram is taken at the height of forced inspiration there is a cap-shaped transparent region occupying the posterior part of the cupola of the diaphragm. Diagrammatic sketches are given showing the anatomy of the lower median border of the posterior part of the lung, from which it is evident that the picture is formed by that portion of the lung, which is thick enough to mask the opacity of the subdiaphragmatic organs. The boundary of the clear area is almost continuous with the posterior border of the pericardium. This finding shows a new part of the lung rendered accessible to roentgen examination.—*Audrey G. Morgan.*

Kjerp, Gunnar. Pleural calcification. *Acta radiol.*, 1932, *13*, 334–348.

Calcification of the pleura is generally unilateral. It usually develops in the costal pleura and most frequently in males. The localization is generally in the outer part of the middle section of the lung field and need not necessarily be in a thickened part of the pleura. The calcifications vary in number, form and size from granular structures to large bodies and shells which completely surround the lung. The process develops through fibrous and hyaline stages to complete calcification. The chemical composition is the same as that of bone. The condition remains latent or relatively so. The clinical symptoms are the same as those of thickening of the pleura only more pronounced. The diagnosis is made by puncture and roentgen examination. Differential diagnosis must be made from tumor and tuberculosis; this differentiation can be made by stereoroentgenography. The prognosis and treatment depend on associated conditions. There are two elements necessary to cause the disease: a necrotic tissue capable of extracting calcium from the blood and a certain constitution or diathesis, which brings about a change in the solution of the calcium salts. There is generally a history of tuberculous pleurisy or of traumatic hemothorax.

Five cases are described and illustrated with roentgenograms.—*Audrey G. Morgan.*

Scarinci, Carmelo. Corpi fibrinosi multipli nel cavo pleurico com rara complicanza di pneumotorace terapeutico. (Multiple fibrinous foreign bodies in the pleural cavity an unusual complication of therapeutic pneumothorax.) *Radiol. med.*, May, 1932, *19*, 485–493.

A few cases have been described in the medical literature in which free fibrinous foreign bodies formed in the pleural cavity in therapeutic pneumothorax. The author reviews them and describes a case of his own. Authorities differ as to the cause of these foreign bodies. Some authors think they are a result of hemorrhage after refilling. Organized extravasations of blood form free foreign bodies. Others think a small blood clot forms a central nucleus around which fibrin stratifies. Still others believe that the bodies are formed by progressive solidification of a serofibrinous exudate. The author believes this theory as there is generally an exudative pleurisy in these cases and the bodies that have been examined histologically have shown no blood corpuscles.—*Audrey G. Morgan.*

Torelli, Gastone. Un particolare quadro radiologico del pneumotorace: il pnx opaco. (An unusual picture in pneumothorax: opaque pneumothorax.) *Radiol. med.*, Feb., 1932, *19*, 109–121.

The normal picture of pneumothorax is well known. The collapsed lung gives a dark shadow and there is a clear space corresponding to the air-filled space of the pneumothorax. But in certain cases this picture is reversed, that is, the pneumothorax cavity gives a darker shadow than the collapsed lung. The author describes 12 such cases and gives illustrative roentgenograms. This picture is probably caused by thickening of the parietal pleura around the pneumothorax cavity.—*Audrey G. Morgan.*

Asti, Luigi Mario. Metastasi polmonari osteogenetiche da osteosarcoma del femore. (Osteogenetic lung metastases from osteosarcoma of the femur.) *Radiol. med.*, April, 1932, *19*, 416–424.

A student of sixteen suffered a trauma while taking gymnastic exercises and shortly afterward a swelling developed on the inner side of the lower third of the left thigh. Biopsy showed osteosarcoma of the femur and the leg was amputated. A few months later he began to have pain in the left shoulder and was sent for roentgen examination. It showed a number of round shadows in the left lung field; they were the size of a pea to that of a large walnut, with distinct outlines and varying sizes. Some of them showed a sort of bone structure with radiating lamellae. There were also opaque nodules in the right lung but they did not show the characteristic bone structure of those in the left. A diagnosis was made of lung metastases from osteosarcoma of the femur. The patient's condition grew rapidly worse and he died in about a month of bronchopneumonia.

The author discusses the differential diagnosis of bone metastases from chondroma of the lung, primary ossifications of the lung, dermoid cysts and calcifications of the pleura.—*Audrey G. Morgan.*

Cooper, Finis G. The association of tuberculosis and carcinoma. *Am. Rev. Tuberc.*, Jan., 1932, *25*, 108–147.

In a review of the statistical data concerning the association of carcinoma and tuberculosis it is difficult to find evidence of antagonism between the two diseases. Conclusions from experimental studies have been contradictory in some cases but most of the evidence at present appears to support the conclusions of those who maintain that tuberculosis and carcinoma are not antagonistic. The accumulation of a large number of cases in which the two diseases have been intimately associated offers fairly convincing evidence that an antagonism does not exist. In many reports authors have attempted to determine which process is primary. Usually tuberculosis was believed to be the earlier process, particularly in the cases in which the conditions were coexistent in the lung and in which the carcinoma appeared to develop in an old tuberculous cavity. In order to determine whether tuberculosis exists with all degrees of malignant tumor, carcinomas were graded according to Broders' index. All degrees of malignancy were noted. The finding of tuberculosis in an organ or biopsy specimen does not exclude the possibility of malignant tumor. It would appear from this study that the association of malignant and tuberculous lesions had better be recorded as a mere coexistence of two diseases until more is known about the cause of carcinoma.—*G. R. Miller.*

ABDOMEN

Wagner, Aage. Esophageal orifice hernia. *Acta radiol.*, 1932, *13*, 466–482.

The author briefly reviews a number of recent publications on the subject of hernia of the esophageal orifice and then describes the clinical and roentgen findings in 11 cases of this disease. Most of the symptoms shown by these patients were dyspeptic and cardiac and in 8 of them it was overwhelmingly probable that the symptoms were due to the particular type of hernia from which they were suffering. In the other 3 cases there were other causes to account for the symptoms. He believes that operation should not be performed unless it is necessary to save the patient's life. He thinks conservative treatment is effective in the majority of cases.—*Audrey G. Morgan.*

Finsterbusch, R. and Gross, F. Der Wert des frühzeitigen röntgenologischen Nachweises des spontanen Pneumoperitoneum bei perforierten Magengeschwür und sonstigen Erkrankungen des Verdauungstraktus. (The value of early roentgen demonstration of spontaneous pneumoperitoneum in perforated stomach ulcer and other diseases of the digestive tract.) *Acta radiol.*, 1932, *13*, 567–590.

The results of operation in perforated ulcer of the stomach and duodenum depend chiefly on how soon operation is performed. When a large amount of gas enters the abdominal cavity the liver dullness is decreased or abolished but it is then often too late for successful operation. Very small amounts of gas can be demonstrated by roentgen examination and so diagnosis can be made very much earlier. Roentgen examination can now be made without any danger or inconvenience to the patient by means of horizontal irradiation with the patient lying on his back or side. The authors prefer the left lateral position because in that position very small amounts of gas can be seen more readily in contrast with the dense shadow of the liver, the diaphragm and the lateral wall of the abdomen.

They discuss the literature of the subject and their own results in the examination of 8 early cases of perforated ulcer of the stomach, 2 cases of ulcer of the stomach that perforated as a result of contrast examination, 2 cases of perforated carcinoma of the stomach, 12 of perforated ulcer of the duodenum, 3 late cases of ulcer perforation, 1 of rupture of the small intestine from blunt injury of the abdomen, 1 of gunshot injury of the small intestine, 4 of rupture of ulcers of the intestine from distention in ileus, 1 of perforated appendix, 2 of perforated gallbladder and 5 of postoperative accumulations of gas in the abdomen.

The gas is generally sickle-shaped and even in early cases there may be a fluid level. This point is emphasized because a fluid level has generally been considered an evidence of abscess. The absence of gas does not absolutely disprove perforation but gas is present in a large percentage of the cases—in 86 per cent of 110 cases reported in the literature. The roentgen method has proved of great value in the prognosis of covered perforation. It is also of great value in diagnosing perforations from unusual causes such as stretching of ulcers in ileus and traumatic perforations.—*Audrey G. Morgan.*

Jankelson, I. R. Peptic ulcers in children. *Am. J. Dis. Child.*, July, 1932, 44, 162–165.

Jankelson reports 3 cases of peptic ulcer in children. The first patient was a boy of twelve years, the second a boy of ten, and the third a girl of twelve. In the first case the roentgen examination showed a niche on the lesser curvature; in the second it showed a persistent irregularity of the duodenum without a six-hour gastric residue, and in the third a prepyloric ulcer with a six-hour residue was noted.

Jankelson concludes that peptic ulcers in children are more common than is generally realized. Many cases are clinically overlooked. Peptic ulcers should be suspected in a child with chronic digestive disturbances not explained by any other demonstrable pathologic process. The finding of occult blood in the stools is suggestive of the condition. A roentgen examination of the digestive tract demonstrating a typical deformity is the only means of arriving at a correct diagnosis. The treatment for uncomplicated peptic ulcer is medical. Complications in cases of peptic ulcers must be treated accordingly, perforations requiring immediate operation, and hemorrhage and a partial pyloric obstruction being treated medically by choice and surgically from necessity only.

Foci of infection, particularly tonsillitis, are common in children, and must be eradicated if the best results are to be obtained. However, Jankelson warns, the removal of healthy tonsils, no matter how hypertrophied, will not help in the control of the symptoms of ulcer; the removal of diseased tonsils, per se, will not cure patients with ulcers. The appendix is sometimes removed as a possible focus of infection. But Jankelson does not regard it as justifiable to expose a child to a major operation in the hope of eliminating a focus of infection which in the individual case may have nothing to do with the presence of the ulcers.—*R. S. Bromer.*

Lupacciolu, Giovanni. Un caso di ulcera pilorica "vis-a-vis." (A case of ulcer of the pylorus "vis-a-vis.") *Radiol. med.*, March, 1932, *19*, 344–346.

A patient aged thirty-nine with symptoms of stomach ulcer had had several roentgen examinations, all of which had been negative. The author took a number of roentgenograms with the patient in the right lateral position, all of which showed the pylorus filled and on each of its walls, just opposite each other, two opaque spots which were interpreted as ulcer "vis-a-vis," like that described some years ago by Busi in the duodenum. The duodenum and small intestine were apparently normal. The cecum was dilated but mobile and somewhat painful on pressure. The appendix was mobile but intensely painful. A diagnosis was made of ulcer of the pylorus vis-a-vis which had affected the appendix. The patient refused operation on account of the previous negative roentgen examinations. He was obliged to come back about two weeks later, however, on account of copious melena and operation confirmed the diagnosis.—*Audrey G. Morgan.*

Anzilotti, Alberto. Ulteriori osservazioni su di un caso di tumor peduncolato dell stomaco radiologicamente diagnosticato e operatoriamento controllato. (Final report on a case of pedunculated tumor of the stomach diagnosed roentgenologically and controlled by operation.) *Radiol. med.*, July, 1932, *19*, 717–718.

In an article published in *Radiol. med.*, April, 1930, vol. *17*, the author described a case of tumor of the stomach in which the roentgen picture showed a lacunar zone partly in the antrum of the pylorus, partly in the duodenum, from which a diagnosis was made of gastric polyp with a lobulated surface which invaginated intermittently into the duodenum. Operation was advised on account of intermittent melena but the patient refused, so the diagnosis could not be confirmed.

The hemorrhage continued for two years and the patient returned. Roentgen examination showed the same findings and the patient consented to operation. Gastrotomy was performed and the roentgen diagnosis confirmed. A tumor with a long pedicle invaginated into the duodenum, where it extended into the second portion, was removed. Histological examination showed that it was a benign polypous polyadenoma.—*Audrey G. Morgan.*

VOLUME XXX DECEMBER, 1933 NUMBER 6

[FOUNDED IN 1906 AS THE AMERICAN QUARTERLY OF ROENTGENOLOGY]

The AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

OFFICIAL ORGAN
THE AMERICAN ROENTGEN RAY SOCIETY
THE AMERICAN RADIUM SOCIETY

LIBRARY OF CONGRESS JAN 1934 MEDICAL DIVISION

Editor: LAWRENCE REYNOLDS, M.D.

Editorial Board

A. C. CHRISTIE, M.D. E. H. SKINNER, M.D. LAURISTON S. TAYLOR

Advisory Board For Pathology

JAMES EWING, M.D. EUGENE L. OPIE, M.D.

ISSUED MONTHLY FOR THE AMERICAN ROENTGEN RAY SOCIETY
BY CHARLES C THOMAS, PUBLISHER, SPRINGFIELD, ILLINOIS

AMERICAN ROENTGEN RAY SOCIETY
Thirty-fifth Annual Meeting *Pittsburgh, Pa., Sept. 25-28, 1934*

AMERICAN RADIUM SOCIETY
Nineteenth Annual Meeting *Cleveland, Ohio, June 10-11, 1934*

FOURTH INTERNATIONAL CONGRESS OF RADIOLOGY
Zurich, Switzerland · July 24-31, 1934

YEARLY SUBSCRIPTION, $10.00 INDEX NUMBER SINGLE NUMBER, $1.50

The greatest ADVANCE in Radiography

...since the introduction of the Potter-Bucky Diaphragm

The first and only X-ray apparatus with a built-in system of standardized technique.

The TECHRON

THE TECHRON WAS INTRODUCED AT THE AMERICAN CONGRESS OF RADIOLOGY — CHICAGO — September 25-30, 1933

It was pronounced the outstanding X-ray development since the advent of the Potter-Bucky Diaphragm and received more favorable comments than any other X-ray apparatus on exhibition. It was accorded unanimous praise when Roentgenologists witnessed actual demonstrations—all radiographs routinely being of the same high quality—proving our contention—"result insurance."

- The Techron is a revolutionary development—a complete X-ray apparatus that coordinates the prime factors necessary to produce radiographs of true diagnostic value routinely. It is radically different; it is the answer to your technique problems.
- Nothing like the Techron has ever been known . . . yet it employs in its design principles in use by our research department since 1914—a standardized anatomical energy technique—guaranteeing uniform high quality radiographs consistently.
- You will like its appearance—unique in design, beautifully finished in either statuary bronze and polished brass or black velvet duco and handsome chrome nickeled hardware.
- You unquestionably want to know more about it. Fill in the coupon and slip it in the mail today.

Kelleket X-RAY EQUIPMENT

THE KELLEY-KOETT MFG. CO., INC.
203 West Fourth St., Covington, Ky.

Gentlemen: I am interested in the possibilities of The Techron. Send me descriptive literature (without obligation, of course).

Name .....
Address .....
City ..... State .....

NRA

JAN 18 1934

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. XXX DECEMBER, 1933 No. 6

CONTENTS

The Future of Radiology as a Medical Specialty . . . . . HENRY K. PANCOAST, M.D. 711
Influences Affecting the Future of Roentgenology . . . . . JOHN T. MURPHY, M.D., F.A.C.P. 718
The Relation of the American Society for the Control of Cancer to Radiologists . . . . . C. C. LITTLE, PH.D. 723
Lipiodol in Bronchography: Its Disadvantages, Dangers and Uses . . . . . J. BURNS AMBERSON, JR., AND H. MCLEOD RIGGINS 727
Tuberculosis of the Knee Joint: A Comparison of its Morbid Anatomy with its Roentgenologic Manifestations . . . RALPH K. GHORMLEY, M.D., ... B. R. KIRKLIN, M.D., AND ERNEST A. BRAV, M.D. 747
Congenital Absence of Superior Orbital Wall Associated with Pulsating Exophthalmos . . . . . LEON T. LEWALD, M.D. 756
Pituitary Adenomas . . . . . ROBERT C. MOEHLIG, M.D. 765
"Miliary" Pulmonary Hemorrhages on Necropsy Roentgenograms of Children . . . . . WILLIAM E. ANSPACH, M.D. 768
Further Cholecystographic Studies in the Late Months of Pregnancy . . LESTER LEVYN, M.D., EDGAR C. BECK, M.D., AND A. H. AARON, M.D. 774
Ileocecal Tuberculosis and the Double Contrast Enema Examination . . . . . JACOB GERSHON-COHEN, M.D. 779
The Appendix, Morphologically Considered . . . . . RICHARD A. RENDICH, M.D., AND BERNARD EHRENPREIS, M.D. 791
Separation of the Symphysis Pubis, with Report of Five Cases . . . . . E. J. BERTIN, M.D. 797
Gastrohepatic Fistula: Case Report . . . . CLINTON G. LYONS, M.D. 804
Late Results from Combined Electrocoagulation and Irradiation of Superficial Cancers . . . . . H. H. HAZEN, M.D. 806
An Epiphyseal Chart . . . . . PAUL C. HODGES, PH.D., M.D 809
Editorial
March Foot or Pied Forcé 812
Society Proceedings, Correspondence and News Items 814
Department of Technique
A Combined Sinus and Mastoid Head Rest . . . . . RALPH E. HERENDEEN, M.D., AND FRANK HUBER, M.D. 817
Index to Abstracts 821
Abstracts of Roentgen and Radium Literature 821
Index to Volume XXX 835

GENERAL INFORMATION

Manuscripts offered for publication and other correspondence relating to the editorial management and books for review should be sent to Dr. Lawrence Reynolds, Editor, 110 Professional Bldg., Detroit, Michigan. Contributions may be sent in foreign languages and will be translated if found acceptable. Original articles are published only with the understanding that they are contributed exclusively to this JOURNAL.

A certain number of illustrations will be supplied free of cost; but special arrangements must be made with the Editor and Publisher for excess illustrations and elaborate tables.

Fifty reprints are furnished without charge to authors. Additional reprints may be purchased according to a scale of prices that accompanies galley proofs.

For information regarding membership in the American Roentgen Ray Society, address the Chairman of the Executive Council, Dr. Charles A. Waters, 1100 N. Charles St., Baltimore, Md.

For information regarding the program of the annual meeting, address the President-Elect, Dr. John T. Murphy, 421 Michigan Street, Toledo, Ohio.

Correspondence regarding subscriptions, advertisements, and other business relating to THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY should be addressed to Charles C Thomas, Publisher, 220 East Monroe Street, Springfield, Illinois. Foreign subscriptions may be addressed to Baillière, Tindall & Cox, 7 and 8, Henrietta Street, Covent Garden, London, W. C. 2, England; H. K. Lewis & Co., Ltd., 136, Gower Street, London, W. C. 1, England; Maruzen Co., Ltd., 11–16 Tori-Sanchome, Nihon-bashi-Ku, Tokyo, Japan; Beutelspacher & Cia., Sarmiento 815, Buenos Aires, Argentina; W. Watson & Sons, Ltd., Watson House, Bligh Street, Sydney, Australia; or to your own agent.

Subscription price a year: $10.00, United States; $11.00, Canada; $12.00, other countries. Current single numbers, $1.50.

SUGGESTIONS FOR PREPARATION OF MANUSCRIPTS

Manuscripts should be typewritten, with double spacing, and good margins (not on thin paper) and the *original* should be sent to the Editor. The author should keep a carbon copy, as the original is not returned. The name of the author should appear on each sheet of manuscript. Tabular materials should be typed on separate sheets; likewise bibliographical lists, footnotes, etc.

Drawings and charts for reproduction should be made in black (*never* in blue). Photographic prints of plates or slides on glossy paper produce the best half-tones.

All photographs and drawings intended for illustrations should be numbered, the top plainly indicated, and an abbreviated title of the paper placed on the back of *each one*.

Legends for illustrations should be typewritten in a single list, with numbers corresponding to those on the photographs and drawings, instead of attaching each legend to its corresponding picture.

Care in preparation of bibliographies will save much time and correspondence. Each reference in a bibliography should include the following information in the order indicated: Name of the author with initials; title of the article; name of the periodical: year, volume, and page. It is requested that the authors use the following as a model:

1. Gardner, W. J., and Frazier, C. H. Ventriculography without air injection. J. Am. M. Ass., 1929, 93, 193–194.

The month should be given if the reference is to an issue of the current year. An alphabetical arrangement of authors is preferred.

The author should always place his full address somewhere on his manuscript. This is very important and is often omitted.

The American Journal of Roentgenology and Radium Therapy is owned, maintained by, and in the interests of, the American Roentgen Ray Society, Inc. It is issued monthly by Charles C Thomas, Publisher, 220 East Monroe Street, Springfield, Illinois.

The American Journal of Roentgenology and Radium Therapy does not hold itself responsible for any statements made or opinions expressed by any contributor in any article published in its columns.

Entered as second-class matter February 10, 1930, at the postoffice at Springfield, Illinois, and Menasha, Wisconsin, under the Act of March 3, 1879. Accorded the special rate of postage provided for in paragraph 4, section 412, P.L. and R.

Copyright 1933 by American Roentgen Ray Society, Inc.